Ali A. Nouri

GIS-Supported Environmental Assessment for Landscape Planning

Model and Requirements on the Regional and Community Levels for Iran

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GIS-Supported Environmental Assessment for Landscape Planning

Model and Requirements on

The Regional and Community Levels for Iran

Case Study: Yakhkesh Area, Mazandaran Province, the Caspian Region

A Dissertation to Obtain the Degree of Doctor at

George-August University of Goettingen

Faculty of Forest Sciences and Forest Ecology

Nature Conservation & Landscape Planning Unit

With Support of

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By

Ali A. Nouri

Born in Shahrood – Iran

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To My Beloved Lady: Sara

My Dear Parents: Tahereh & Mohammad Hossein

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Göttingen, March 2008 **Ali A. Nouri**

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ABBREVIATIONS

AB	Agricultural Bank
DC	Department of Cultivation (agriculture)
DH	Department of Horticulture
DL	Department of Livestock affairs
DPP	Department of Propagation and Production system
DRID	Department of Rural Industries and Rural Development
DWS	Department of Water and Soil management
ETM	Enhanced Thematic Maper sensor of the Landsat satellite mission
FRO	The former Forest and Rangelands Organization
FRWO	The Forests, Rangelands and Watershed Organization
GEF	Global Environment Facility
MPO	Iran Management and Planning Organization
ME	Ministry of Energy (water and power)
MENCNS	Ministry for the Environment, Nature Conservation and Nuclear Safety (Germany)
MHUD	Ministry of Housing and Urban Development
MI	Ministry of Interior
MOAC	Ministry of Agricultural Crusade (Jahad)
MP	Ministry of Petroleum
MPCW	Ministry of Public Cooperation and Welfare
MRT	Ministry of Road and Transportation
MSS	Multi-spectral Scanner of the Landsat satellite mission
NICC	National Iranian Cartographic Center
NIOPDC	National Iranian Oil Production and Distribution Company
ORC	Organization for Rural Cooperatives
PG	Provincial Governor – general
RIFR	Research Institute for Forests and Rangelands
TM	Thematic Mapper sensor of the Landsat satellite mission

ABSTRACT

The lack of an efficient environmental planning and management system has always been considered as a basic problem towards achieving sustainable development in the Caspian Region, North of Iran. The Caspian forests are a globally and nationally important source of Biodiversity, which face numerous threats. During the past decades, the narrow economic base in the mountainous areas and the very limited opportunities for income generation, as well as increasing population pressures led to over utilization of the natural resources by the rural communities. Additionally, a lack of monitoring and of public participation in forestry as well as in other planning sectors increased illegal activities and over-utilization of the natural resources by private enterprises and local people. Soil erosion, accompanied by destructive floods and declining fertility as well as productivity, resulted in severe degradation of natural habitats with negative socio-economic consequences. It is clear that the future development of the region should be conducted in a sustainable manner, in which environmental conservation and protection goals can be achieved in company with socio-economic needs of the society. Since 1980, an environment-based land use planning has been developed from an analogue process to a semi-automated one in which, GIS software and Remote Sensing techniques are used, not only to increase the speed but also the accuracy of the planning process. Although, it has been successfully used as a guideline for spatial planning on both national and regional levels, it could not bring efficient and practical solutions on the local scale. This may partly be caused by legal and administrative constraints, but it also results – to a large extend – from a purely top-down procedure, which does not facilitate an active participation among all stakeholders in both, planning and implementation phases. As this is the best available national planning system, which has been developed so far, all of the efforts should be focused on the enhancement and improvement of its capabilities by identifying and then removing its weaknesses. To achieve this, a comprehensive literature review is made to find the possibilities and alternatives. It seems that "landscape planning" in the modern German meaning of "Landschaftsplanung" could serve as a very effective tool to improve the current process of land use planning in Iran, especially on the local scale.

This study presents an analysis of the landscape management problem in order to detect the immediate and underlying threats to the sustainable utilization of the natural resources, esp. forests, in a sample area (Yakhkesh Mountains) of the Caspian mountainous ecosystem. Using questionnaire method, a community (socio-economic) assessment was conducted to gain the ideas and comments of the villagers and local/national experts about the current management system, its weaknesses and possible solutions to prevent negative social as well as ecological consequences of the forest loss. After collecting and processing the available ecological and socio-economic data, a GIS-based ecological assessment was made using the both Iranian and the German approaches. Some scenarios were developed based on the experiences and results of the past and recent national and international projects across the region. The draft plans were then assessed by both villagers and Iranian experts to finalize the planning scenario. The results revealed that there are many possible solutions to overcome the mentioned problems, which could be presented in an integrated management plan with close cooperation of the all stakeholders. Therefore, an operational mechanism is suggested to use the current development programs in an integrated manner. Although, access to the detailed and up to date data is still a main problem, the available ecological and socio-economic data could be more efficiently used for a participatory nature conservation and landscape management in Iran. This process could be improved through "learn by doing", which again shows the importance of the implementation and monitoring of the plans that unfortunately remain as a big problem in Iran.

CHAPTER I

INTRODUCTION

The major part of Iran is occupied by a moderately elevated interior basin that is bounded by high mountain systems along its Northern and Southwestern margins. The North chain, e.g. the Alborz (Elburz), represents a North branch of the Alpine-Himalayan orogenic system and runs for a distance of 960 km, separating the Caspian Lowland from the Central Iran Plateau. Ranging in width from 70 to 130km with many summits from 3600 to 4800 m in altitude, the Alborz culminates in the 5670 m volcano Mount Damavand (GSI, 2007).

The Caspian forests in northern Iran are considered one of the last remaining temperate natural deciduous forests in the world. The Mediterranean plant elements experienced significant changes due to their spread in the Tertiary Period. In other words, a number of them such as Beech (Fagus sp.) and Siberian Elm (Zelkova sp.) in Austria and Sweet gum (Liquidamber sp.) in Cypress and on the Kert islands were naturally selected. For instance, the genus Liquidamber was much more widespread in the Tertiary, but has disappeared from Europe due to extensive glaciations in the north and the Alps, which has served as a blockade against southward migration (Hsu & Andrews, 2005). However, the forested areas in the southeastern coasts of the Black Sea and south of the Caspian Sea remained intact and some plant archaeologists consider them as relict ecological systems. Along with similar North American and East Asian forest communities, these areas (e.g. southeast of the Black sea and south of the Caspian Sea) are nowadays seen as a Tertiary Period deciduous belt containing communities formerly associated with each other (RIFR 2006).

Iran is a contact point of the five phytogeographical regions1 and the Caspian forests are located in the Hyrcanian sub-region of the Euro-Siberian region (see Figure 1 & Picture 1). This sub region covers an area of about 1.9 million ha, with a width of 20 to 70 km, from the southern coast of the Caspian Sea, up to the high mountains of Alborz, and a length of 800 km, from Gorgan to Astara (see Figure 2).

Its annual rainfall varies between 1850 mm in the West and 588 mm in the East (Sabeti, 1976). There are 65 different tree species in the region among which, some relict species, indicators of the Tertiary Period such as Zelkova carpinifolia, Parrotia persica and Pterocarya fraxinifolia are found.

Of 80 woody plants reported in the region, 45 species (ca. 60%) belong to the late Pleistocene.

[1] Euro-Siberian, Turanian, Mediterranean, Sahara-Sindian and Sudano-Decanian

Picture 1: Some pictures of the Caspian forests, North of Iran (source, RIFR 2004)

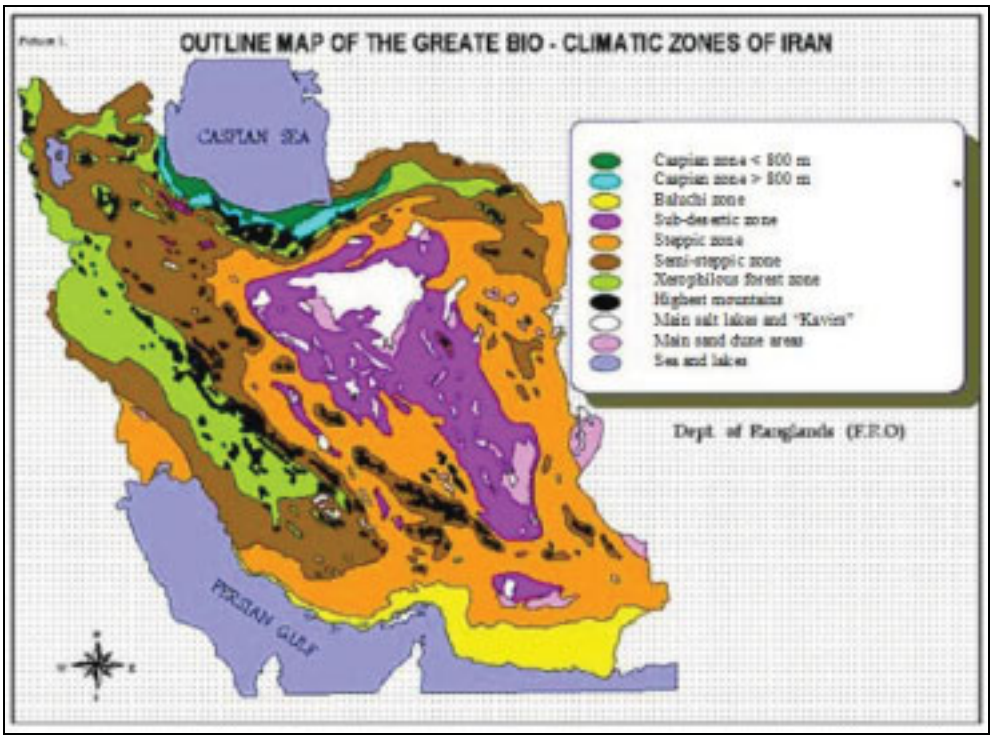

Figure 1: Bioclimatic zones of Iran (Source: Badripour, 2006)

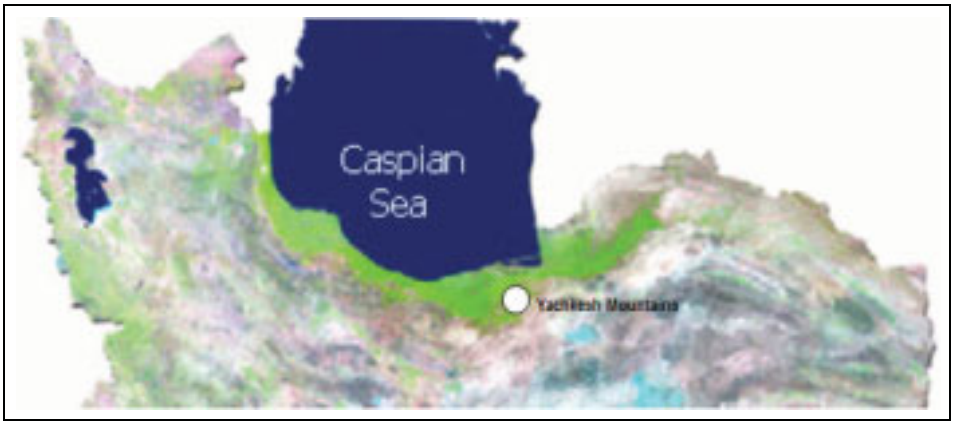

Figure 2: Geographical location of the Caspian Forests (light green) on a true Color Composite image of TM-Landsat of Iran (Source: Darvishsefat, 2002). White circle shows the approximate location of the study area

The extent of the Hyrcanian forests almost did not change during the entire Quaternary period, at least until the end of the Ice Age. It also includes about 60 species of shrubs and provides habitats for a huge number of wildlife species (RIFR, 2006). Thus, the Caspian forests are considered to be a globally and nationally important source of Biodiversity. However, they are in urgent need of protection measures and management regimes to secure their natural resources.

During the past decades, the narrow economic base in the mountainous areas and the very limited opportunities for income generation, as well as an increasing population pressure led to over utilization of the natural resources by the rural communities. Additionally, a lack of monitoring and of public participation in forestry plans increased illegal logging and overexploitation by private enterprises and local people. In mountainous areas, the livelihood system of the human communities is one of the main problems towards achieving sustainable management of the natural resources, especially forests. Cultivation and cattle-raising are the main sources of income for around 55 percent of the population, who are living in the rural areas of the Mazandaran Province (1996 census).

Due to the natural weakness of the mountainous areas for cultivation, the traditional living system is highly dependent on the forest resources. This however led to an accelerating degradation of the vegetation covers, especially during the past 3 decades. In 21 catchments areas of the main rivers of Iran, around 738 million tons of arable soils have been lost each year due to water erosion (Yakhkeshi, 2002). Increasing incidence of soil erosion, accompanied by destructive floods and declining fertility and productivity, resulted in severe degradation of natural habitats as well as negative socio-economic consequences (see Figure 3). The National Reports to the Convention of Biological Diversity (CBD) put great emphasis on the preservation and rehabilitation of the northern forest ecosystems in Iran, recognizing serious degradation and the need to take action. In these reports, threats are specified as “land clearance for agricultural use, illegal logging, forage production, overgrazing, firewood, and charcoal production”, which have reduced deciduous temperate forests by almost 40% over the past 30 years (DoE, 2004).

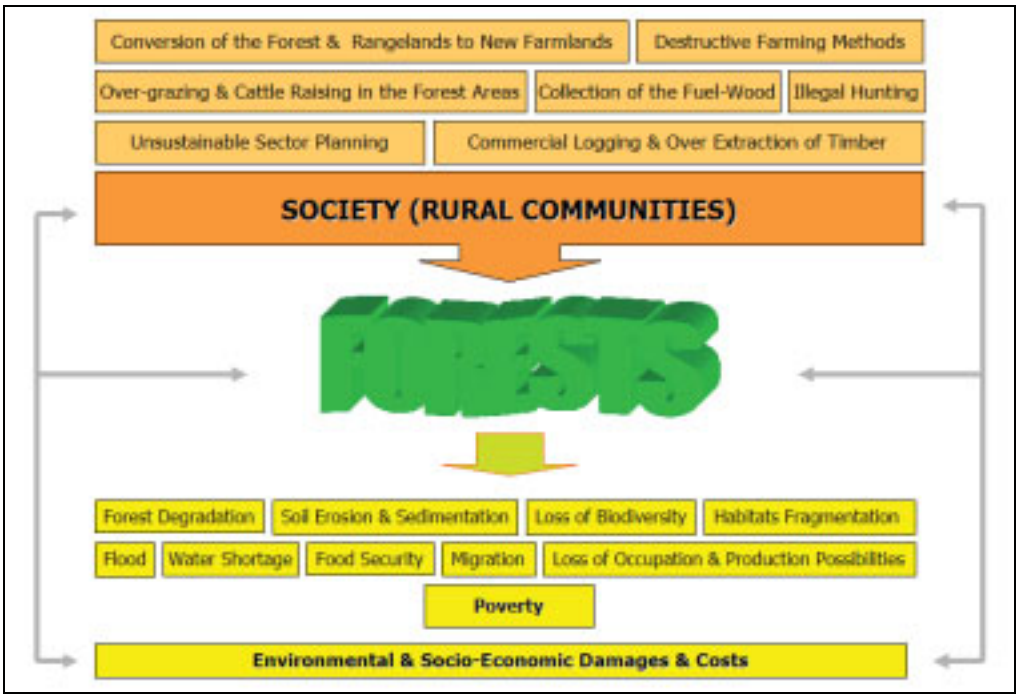

Figure 3: Anthropogenic pressures on the forest resources led to many negative ecological and social consequences (Nouri, 2005)

In addition to that, forest management plans were executed in these areas, where the local communities had developed - for centuries - their traditional utilization system for timber extraction, firewood collection and cattle-raising. The implementation of the forestry plans did not improve forest management but led to a competition between logging activities by the governmental or private sectors and the local villagers, accelerating the anthropogenic pressures on the forest resources.

Until now, most of the current planning approaches for sustainable land use (forestry, agriculture, watershed management, nature conservation, etc.) have been executed in a strictly sector-based top-down manner, without proper attention to the social potentials and needs of the people, especially on the community level. The lack of an efficient comprehensive environmental planning and management system seems to be a basic problem towards achieving sustainable development. It is clear that future development of the country needs to be conducted in a sustainable manner, in which environmental conservation and protection goals can be achieved in accordance with socio-economic needs of the society. The First National Report identified serious threats to non-protected areas from unsustainable land-use practices. It recommended major changes in the existing land-use patterns in order to address land degradation. Appropriate land-use plans and sustainable natural resource management are therefore a

priority for the country, particularly in the sensitive mountain areas. This may be supported by the process of spatial planning.

The existing environment-based land use planning concept (Makhdoum 1988 & 2002) has been successfully used as a guideline for spatial planning on the both national and regional levels. However, it could not bring efficient and practical solutions on the local scale. To a certain extent this deficiency may be caused by the lack of accurate and up-to-date data and of well-experienced planners as well as by legal or administrative constraints. Nevertheless, the most important reason is its top-down approach, which does hamper an active participation, understanding and acceptance of stakeholders in both, planning and implementation. Thus, an efficient integrated environmental planning and management system that balances the environmental conservation and protection goals with the socio-economic needs is still lacking. As the current approach is the best available national planning system which has been developed so far, all efforts should be focused on the enhancement and improvement of its capabilities by identifying and then removing its restrictions.

The research hypothesis for the following study is that the major stresses causing environmental damages in the Northern forests of Iran are related to the inappropriate development and over-utilization of the environmental resources, as a result of the top-down planning procedure with insufficient accuracy and practicability on the local scale; insufficient attention to the nature conservation and landscape management aspects; as well as deficient consideration of the local peoples needs in the current planning approaches. However, the lack of cooperation with the local communities is certainly not the only shortcoming of the planning approach. There might be also others that root in the entire conceptual framework, in the availability, quality and proceeding of the needed data, or even in the capacities of the planning staff, which have to be identified and taken into consideration in order to achieve a more efficient and successful planning procedure.

Thus, this study intends to develop a model for the sustainable management of mountain forest ecosystems that could be operated in close cooperation with local communities and governmental organizations. It mainly focuses on the protection of the forests, soil and water, while paying attention to the socio-economic needs and potentials of the rural society in a more integrated manner. It thereby intends to demonstrate the tremendous potential for integrated community-based management approaches for the protection and sustainable use of other important forest ecosystems in the Caspian region, Northern Iran.

The main goals are as follows:

- To do an exemplary root-cause analysis of forest degradation and its negative environmental consequences in Yakhkesh (Mazandaran Province), as a representative area for the mountain forests of the Caspian region.
- To refine the general GIS-based planning approach for ecological assessment in Iran, as the basic concept for nature conservation and land use planning
- To identify restrictions, deficiencies and obstacles, which are existing for environment-based regional and, more specifically for community planning
- To find alternative solutions, regarding the both ecological and socio-economic potentials and needs
- To use all of these experiences to extract a concept and recommendations for improvement and increasing the practical aspects and the participatory level of the ecological planning procedure, especially on the community level in Iran

For this purpose, the following study will theoretically reveal the existing spatial planning and natural resources management approaches in Iran in order to identify the main weak points and restrictions that could negatively affect the practicability and quality of the results (chapter II). It then looks for alternative concepts that provide a more substantial and promising consideration of sustainability aspects in the planning procedures through reviewing the general approaches in other countries, especially USA and Germany (chapter III). An exemplary ecological assessment is executed by following the current planning process in Iran and by incorporating parts of the perspective of the German approach for Landscape planning (chapter IV & V). The results of the both ecological and community assessments are used for developing some alternative scenarios, strategies and recommendations, while an operational mechanism is suggested for integrating the current governmental programs and for increasing the level of stakeholders participation in the both planning and implementation processes (chapter VI). Finally and as a conclusive summary, the most important aspects of the study are reviewed (chapter VI).

CHAPTER II

LAND USE & LANDSCAPE PLANNING APPROACHES

2.1 Exemplary approaches

2.1.1 From sectoral planning toward sustainable planning

According to Roberts (1979), man plans because he has an inherent need to shape his own destiny. This need, coupled with man's ability to visualize the future and his belief that he can effectively exercise control, is the fundamental reason he plans. Others like Galbraith (1967) see planning not so much as an inherent characteristic, but as a necessary outcome of the industrialization. A quick look on the planning history for utilization of the natural resources confirms his idea. In fact, the planning process for utilization of the natural resources was started in a completely sector-based manner, in which the main goal – in the case of the forestry, grassland management, mining or industrial development plans - was to achieve more economic benefits (Cocks, 1985). However, purely production or economy oriented uses frequently lead or contribute to very different environmental stresses, e.g. the greenhouse effect and the depletion of the ozone layer, euthrophication, acidification, toxic contamination, the loss of biological variety and biodiversity, the pollution and consumption of soil, water, forest and fish resources, waste dumping, the consumption and destruction of land, the decrease in environmental quality in urban areas stemming from air, water and soil pollution, noises, and the sealing of land (Krönert et al., 2001). By the early years of the 20th century many physical scientists began to address the necessity for more integrated planning disciplines on a regional scale. One of the most notable of these was Benton MacKay, whose seminal book, *The New Explorations* (1928), warned of the environmental consequences of "the metropolitan invasion." In 1939, Troll pointed out the importance of interpreting aerial photos for the integrated observation of landscapes as a whole. After World War II, the continuation of the main social, as well as, environmental problems such as farmers' poverty, degradation of natural resources and destruction and contamination of the environment in industrialized countries, led to the development of more holistic approaches in the framework of spatial planning or land use planning (Malhotra 1980, Nix 1985 and Cocks 1986). It aimed at optimizing the distribution and allocation of land, often in a space-limited context (Van Lier 1998; Botequilha Leitão 2001). During the 1960s, *Land use Planning* was originally started in Canada and Australia in order to prohibit and decrease the inappropriate utilization of the natural resources and related environmental problems. It was then extended to the North America and European countries (Makhdoum, 1993). In most of the European countries, Spatial *Planning* began as a successful and innovative course of study, in which the main planning practice of the 60s, 70s and

80s was dominated by sector plans. However, the spatial planning procedure could not properly bring about the necessary considerations regarding nature conservation and protection of the cultural and amenity values of the landscapes. These aspects became increasingly important with the extension of nature conservation concepts from pure protection towards the integration of nature conservation measures into land use practices.

In Germany, *Landscape Planning (Landschaftsplanung)* came into existence in the 1970s as a reaction to the increased destruction of nature through industrialization (Kiemstedt, 1998). In fact, landscape comprehends both the abiotic and the biotic components, while land use acts as an interface between natural systems and socio-economic systems (Steinhardt & Volks 2001). Landscape planning is a specialized planning instrument for nature conservation and landscape management to preserve wildlife (fauna, flora, habitats), natural resources (water, air, soil), and landscape beauty for recreation. It was somehow synonymous for ecological planning which should contribute to the overall spatial planning process (Breiling, 1999). German *Landscape Planning* further offers nature sound land use alternatives and measure to be taken to preserve, to arrange and to restore the natural environment in settled and unsettled landscapes.

The publishing of the Brundtland report (World Commission of Environment and Development, 1987) and later the United Nations Conference on Environment and development in Rio (UNCED 1992) with insist on sustainable development brought a major change in public attitude. Consequently, this global focus on *Sustainability* also influenced planning processes and planning theory to converge in several respects. It promoted a comprehensive understanding of the interrelationship between men and their natural environment and it pushed *Landscape Planning* as an instrument of integrative open planning for sustainability. After 1992 *"Ecology"* was substituted by the concept of *"Sustainable Development" which* addresses a broader scale of planning contents, namely also socio-cultural and economic aspects. Promoting all these dimensions of sustainability has become an overarching principle (Forman 1995), equally addressing short, middle and long term planning as well as local, regional and global planning (Breiling, 1999). In fact, sustainable planning aspires to link knowledge about sustainability with actions to achieve it. Therefore, it 'implements' or 'operationalizes' the principles of sustainability in planning theory and practice (Ahern, 2005).

Although the *Landscape Planning* approach is characterized by a focus on the linkage of ecological patterns and processes for nature conservation and landscape management, Hersperger (1994) believes that *Sustainable Landscape Planning* should also include the actions and val-

ues of humans, as well as, the social and economic dimensions. Currently, *Landscape Planning* has become more important all over Europe (Breiling, 1999) and Landscape planners are expected to also consider economic and social goals. Thus, the bases for their nature sound planning work are no longer only formed by the physical and biotic but also by the socio-economic aspects of a landscape (Brandenburg et al., 1996). In our modern world, planning by the individual, the corporation, or any unit of government not only is essential but unavoidable. Denying an interest in planning or criticizing the planning efforts of others does not free one from dependence on the future (Clawason & Hall, 1973).

The complexity and scale of the multipurpose planning necessitate a trans-disciplinary approach to address the complexity of the challenge, while integrating stakeholders and engaging citizens affected by the plan in meaningful ways. Ahern (2005) believes that if there is a frontier in sustainable planning, it lies in the development of an adaptive approach to planning in which plans are made with the best knowledge available, but with explicit acknowledgment of uncertainty, followed by monitoring and re-evaluation of plans in order to close the loop, and to 'learn by doing'.

2.1.2 Sustainable landscape planning concepts

Planning has been defined in a variety of ways. However, many of these definitions have been subjected to criticism on the grounds that they have limited validity, include irrelevant elements, or are unsatisfactory in some other respect. Thus, Roberst (1979) suggested that for more valid definitions of planning, it would be more practical if we could describe what those involved in planning really do, than making prescriptions for what those involved in planning should be doing. Regarding land use and landscape planning, following stets could be distinguished, which emphasize the tasks and general sequences of activities that normally occur in the planning process (Hall 1975, Roberts 1979, Steiner 1990, Steinitz 1992, Makhdoum 1992, Kiemstedt 1998, Ahern 2005):

- Formulation of the goals and objectives
- Inventory and analysis
- Development of alternatives
- Study / evaluation of alternatives
- Selection of plan / action
- Implementation

- Monitoring of the results

In reality, the discoveries or decisions made at each step in the process may lead to a reconsideration or modification of the results of previous steps. For example, one may discover that a certain plan or course of action, which fulfills most of the goals and objectives earlier agreed upon simply costs too much to implement. This may lead to a rethinking and reformulation of goals and objectives. Thus, planning is viewed as an open, dynamic process, susceptible to new knowledge or forces. During the planning process, one moves form an *understanding* of what he or his clients seek to change, and the environment in which that change may occur, to the development of a *plan* of action for bringing about the change, to the *taking of actions* required to bring about the change, *to monitoring and evaluating* of the results of those actions; and to any necessary *modification* of the plans of actions (Roberts, 1979).

Planning methods can be interdisciplinary or transdisciplinary. Under *the interdisciplinary approach*, researchers and professionals from multiple disciplines collaborate, share information and achieve a higher level of synthesis and integration. Contemporary researchers argue that *the transdisciplinarity approach* represents a yet higher level of integration in which professionals, non-academic and academic, participate in a process in which knowledge is shared across disciplines and all participants are engaged in decision-making (Tress, Tress and Fry 2005). Under the transdisciplinary model, planning may become more integrated with research, enabling the multidimensional challenge of sustainability to be understood more rigorously with many disciplines involved, and the public (i.e. stakeholders, elected officials) similarly involved in planning and decision making. Nowadays, the level of transdisciplinarity has become a key indicator in sustainable planning. A few promising concepts are presented in the following section, which are used for developing of the methodology in this study.

❖ Steiner's Ecological Planning Model

Steiner's Ecological Planning Model (Steiner, 1991; 2000) addresses multiple abiotic, biotic and cultural goals, with a focus on land-use allocation. The model is an 11-step procedure for studying the biophysical and socio-cultural systems of a place/landscape to reveal where specific land uses may best be practiced. It is based on Ian McHarg's Ecological Planning Method (Steiner, 1991, Ahorn 2005). The Ecological Planning Model includes an emphasis on goal establishment; implementation, administration and public participation through systematic education and citizen involvement throughout the process (see Figure 4). It can be considered transdisciplinary as it involves professionals, experts and citizens in a highly inter-

active process. The framework is adaptable to multiple strategic contexts and it employs spatial concepts in the form of design explorations at a finer scale. The Ecological Planning Model has been applied effectively across a range of cultural and environmental contexts.

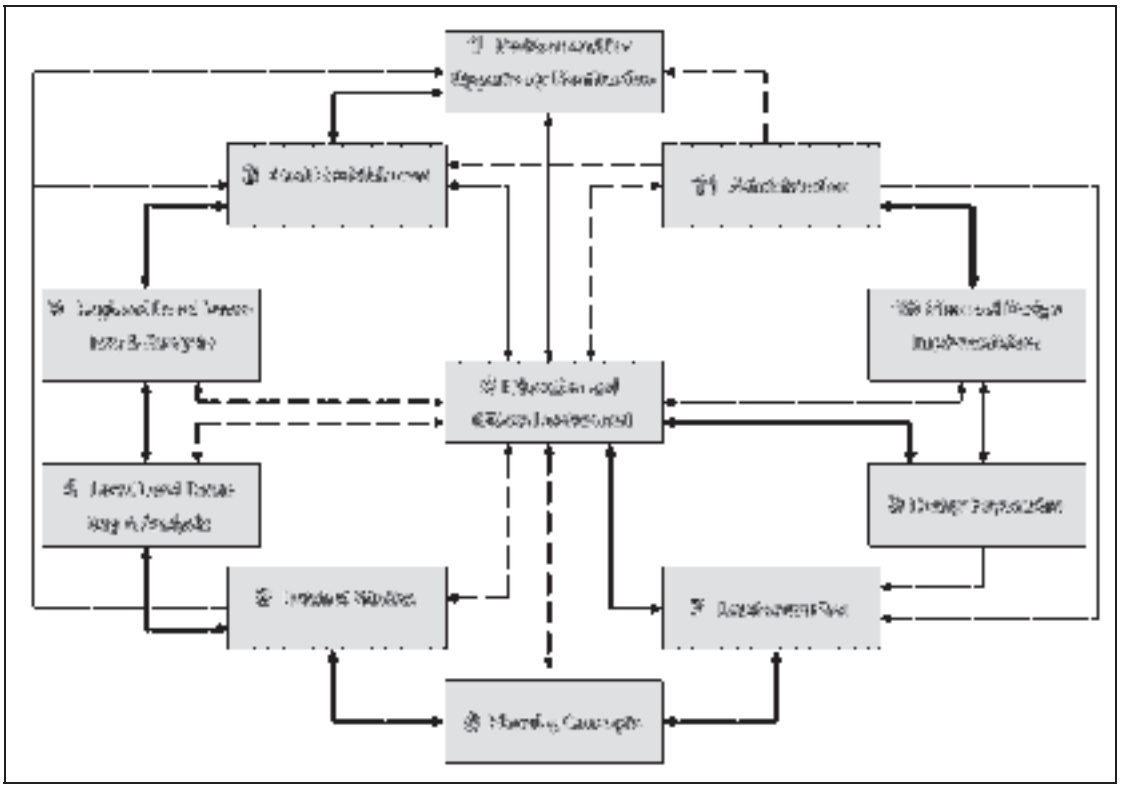

Figure 4: The Ecological Planning Model (Steiner 2000)

❖ Steinitz' Framework Method for Landscape Planning

Steinitz' method for *Landscape Planning* (Steinitz 1990; 1995) is presented as a series of six questions that are fundamental to planning (see Figure 5):

1. Representation: How should the state of the landscape be described in terms of content, boundaries, space and time?
2. Process: How does the landscape work? What are the functional and structural relationships among its elements?
3. Evaluation: How does one judge whether the current state of the landscape is working well? The metrics of judgment include: beauty, habitat diversity, cost, nutrient flow, public health or user satisfaction.
4. Change/Intervention: By what actions might the current representation of the landscape be altered (whether conserving or changing the landscape)?

5. Impact: What predictable differences might the changes cause (i.e., using process models to simulate change)?

6. Decision: How is the decision to change (or conserve) the landscape to be made? How is a comparative evaluation to be made among the alternative courses of action?

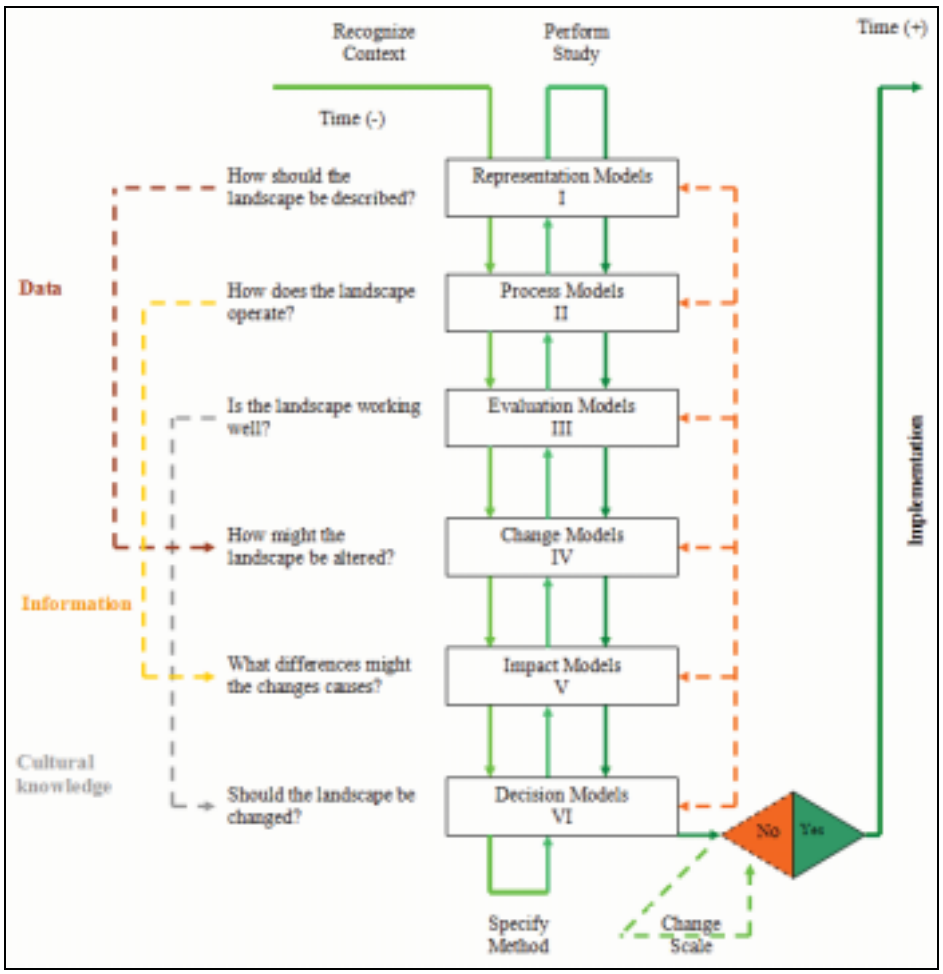

Figure 5: Framework Method for Landscape Planning (Steinitz 1995)

Steinitz' framework provides a robust and flexible process for assessing a landscape and for engaging scientific experts, professionals and stakeholders in an informative, iterative and participatory planning process. The framework is suited to address multiple abiotic, biotic and cultural (ABC) goals, and is adaptable to any strategic planning context. It can be considered transdisciplinary as it integrates public and expert participation. The framework does not include spatial concepts per se. However, in practice it develops alternative future scenarios that represent a form of spatial concept.

❖ Ahern's Framework for "Sustainable Landscape Ecological Planning"

The Ahern's framework method for "*Sustainable Landscape Ecological Planning*" explicitly addresses multiple abiotic–biotic–cultural goals and resources (Ahern 1995; 1999, see Figure 6). The Framework is presented as a linear process, but actually is nonlinear, cyclical and iterative and may be entered at any point in the process (e.g. planning could start with a re-evaluation of an existing plan). It was conceived to be transdisciplinary, as it includes knowledge from science, planning and stakeholders and citizens. The method explicitly acknowledges the strategic context, and relies on spatial concepts to resolve patterns of spatial compatibility and conflict.

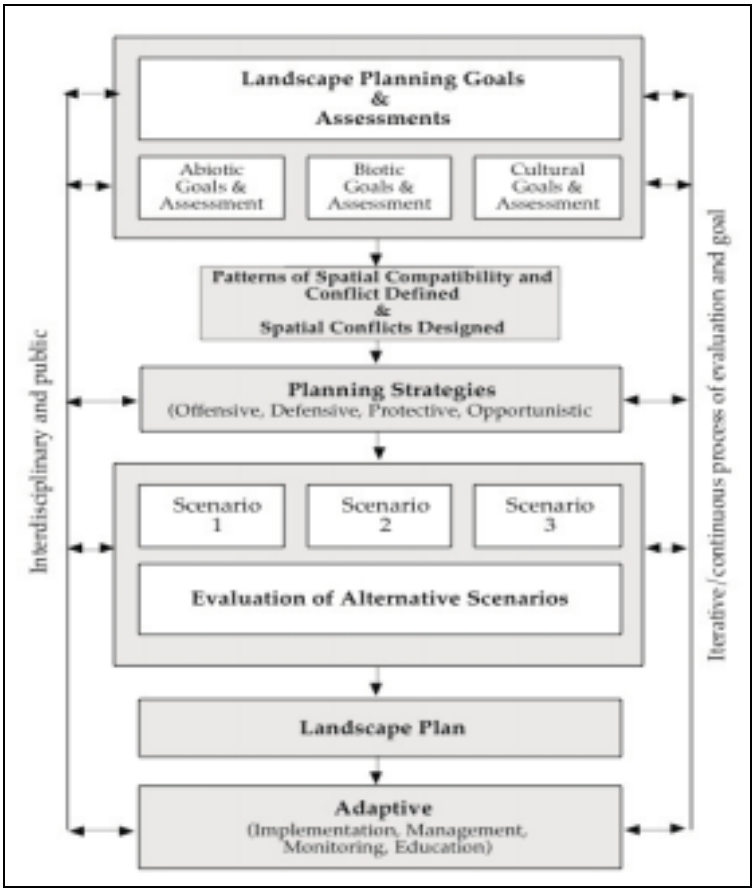

Figure 6: Framework Method for Sustainable Landscape Ecological Planning (Ahern 1999)

As with Steinitz' method, this framework guides the planning process through a series of alternative future scenarios, to inform, inspire and challenge the decision-making process to link planning actions with potential outcomes. The scenarios describe a current situation, some alternative future(s) and the necessary steps or actions needed to link the present with the future. They are not intended to be complete plans, but are appropriate for encouraging in-

formed discussion of alternatives. The scenarios are evaluated with public, expert and stakeholder input. The discussion leads to a landscape plan that is adaptive in terms of implementation, monitoring and education (Ahern, 2005).

2.1.3 The German framework for landscape planning

Landscape Planning has a long history in Germany. The Federal Nature Conservation Act (1976) first stressed the autonomous position held by *Landscape Planning* as the planning instrument of nature conservation and landscape management in comparison to other sectoral planning instruments and administrative procedures. *Landscape Planning* is of particular significance for the assessment of environmental impacts, for the creation of a European network of nature reserves in accordance with the EC Flora-Fauna-Habitat Directive (Habitat Directive) and for the formulation of local development plans (MENCNS, 1998). Although, the contents and procedures of *Landscape Planning* differ in the different Federal States*, Landscape Planning* has established itself as a planning discipline and an important instrument for nature conservation and landscape management (Kimstedt et al. 1998).

It is hierarchically organised following the different administrative and spatial levels: On the *Länder* level (scale: 1:200 000 to 1:500 000), general supra-local requirements, goals and tasks for nature conservation and landscape management are formulated in the *"Landscape Programme"*, while the *"Landscape Master Plan"* has to specify these general goals and tasks and should identify necessary measures for districts and counties (scale: 1:25000 to 1:50000). Most *Länder* further require their communes to draw up a *"Landscape Plan"* (scale: 1:5000 to 1:10000) for their entire rural territory in order to examine the features of nature and the natural environment, access human impacts and identify necessary measures in greater detail. They may also recommend to formulate an *"Open Space Structure Plan"* (scale: 1:1000 to 1:2500) for the settled or urban areas of the communal territory, in order to care for an adequate extend of natural features in urban life.

Both, on the *Länder* and the regional levels, *Landscape Planning* contributes to the environmental orientation of the spatial planning processes and decisions, which may affect nature and landscapes. Thus, the main tasks of *Landscape Planning* are to assemble and evaluate data on the ecosystem and formulate proposals on lastingly safeguarding and developing the following resources (Kiemstedt et al. 1998):

- Species (Fauna and Flora) and habitats

- Nature and landscape related recreation (the amenity value)
- Soil, water, air and climate

There are five basic questions to answer for each *Landscape Planning* procedure (Kiemstedt, 1998):

1. Which components that exist on communal territory, are worthy of protection and display potential for development?
2. Are there indications of present or future disruptions?
3. What will be the consequences of planned projects or land uses?
4. Which long-term overall objectives are aspired to?
5. Which development objectives should to be pursued?
6. Which measures are necessary in this respect?

Figure 7 declares the general phases of the *Landscape Planning* process in Germany. It entails technical and practical steps such as creating an inventory of the existing natural features as well as of the impacts of different land uses, drawing up a concept for a plan of action to reach defined goals for the future development of nature and the landscape and, ultimately, identification of the necessary means and authorities or bodies for the implementation and execution.

The traditional general understanding is that the planning for nature conservation and landscape management should be done independently, as an expert's comment and proposal (expert model). Hence, participatory activities on this level are only involved to a rather limited extend including the information of other involved sectors, institutions and persons and providing consulting services. However, caused by problems concerning public acceptance and implementation of nature conservation measures and supported by the Agenda 21, Landscape Planning tends to integrate participatory processes, at least on the local level of the communes (*discoursive planning model; open planning model;* Wiegleb, 1997).

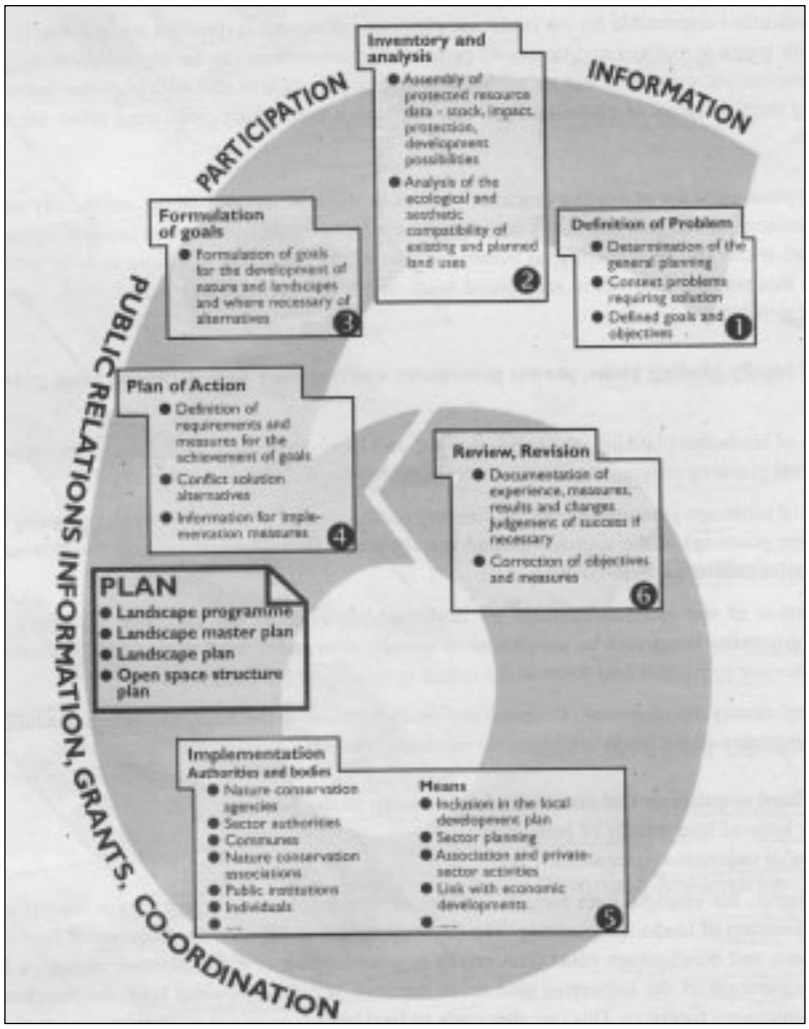

Figure 7: The general phases of the *Landscape Planning* process in Germany (after Kiemstedt et al. 1998)

The final integration of the results however are recommendations into *Spatial Planning* happens afterwards, weighing the goals and proposed actions for nature conservation and landscape management against all other sectoral plans and land use interests *("secondary integration")*. It is evident that by this approach only part of the expert's recommendations compiled in a sectoral *Landscape Plan* will be integrated in the final *Land use Plan.*

2.1.4 Geographic Information Systems (GIS) and landscape planning

Geographic Information Systems (GIS) are computerized systems for the storage, retrieval, manipulation, analysis, and display of geographically referenced data. Since they can include physical, biological, cultural, demographic, or economic information, they are valuable tools

in the natural, social, medical, and engineering sciences, as well as in business and planning (Mark et al, 1997).

GIS has evolved out of a long tradition of map making. In many respects, modern GIS dramatically increases the amount of information that can be contained and manipulated in a map. On the other hand, many of the same cartographic conventions and limitations apply to digital maps. Like all models, maps are, by necessity, simplified representations of reality. Partly, this is for convenience since it becomes very difficult to draw and interpret multiple information themes on one map covering more than a very small area (Monmonier, 1996).

Before computers became widely available, thematic maps on plastic Mylar sheets could be laid on top of each other, revealing more information about an area than was possible with any single paper map. Ian McHarg's classic landscape architecture text, *Design with Nature*, advocated a rational approach to site planning (which he termed physiographic determinism) by creating Mylar overlays depicting landforms, soil types, vegetation patterns, and geomorphic features (McHarg, 1968). Although the process was cumbersome and the amount of data limited, McHarg's method looks remarkably like the output of contemporary GIS. As a result, colure thematic maps were generated that aided in planning. Thus, Burrough and McDonnell (1998) note with respect to these early systems that *"The paper map and its accompanying memoir was the database"*. However, at that time there could be no database of information directly linked to the map and no automation of spatial querying (Brown, 2001). Nowadays, in addition to just drawing maps, further processing the spatial data is possible within the GIS environment and with a more or less immediate outcome as new thematic maps. This procedure has for sure been far too much to expect from the former Mylar overlay techniques.

The detailed history of GIS however is not well understood because GIS technology evolved through multiple parallel but separate applications across numerous disciplines (Pickles, 1999). The *Canada Geographic Information System (CGIS)* is an example of one of the earliest GISs developed. It started in the mid 1960s and its development provided many conceptual and technical contributions. The main purpose was to analyze the data collected by the *Canada Land Inventory (CLI)* and to produce statistics to be used in developing land management plans for large areas of rural Canada. The CLI created maps, which classified various land using themes: soil capability for agriculture, recreation capability, capability for wildlife (ungulates), capability for wildlife (waterfowl), forestry capability, present land use and shoreline. These maps had a simple rating scheme, 1 (best) to 7 (poorest), with detailed qualification codes. Final production of CLI was 7 primary map layers, each showing area objects

with homogeneous zones (Tomlinson, 1987). Another example is the development of the GBF-DIME files by the U.S Census Bureau in the 1960s which marked the large-scale adoption of digital mapping by the Government. This system led to the production of the Census TIGER files, one of the most important socio-economic spatial data sets in use today. Important geographic work was also being done at universities throughout the 1950s and 1960s. A grid-based mapping program called SYMAP, developed at the *Laboratory for Computer Graphics and Spatial Analysis at the Harvard Graduate School of Design* in 1966, was widely distributed and served as a model for later systems (Mark et al, 1997). These early GIS packages were often written for specific applications and required the mainframe computing systems found usually in Government or university settings.

In the 1970s and 1980s, a vigorous GIS industry developed, with clear US leadership. In the 1970s, private vendors began offering off-the-shelf GIS packages. This process led to the development of other systems such as METLAND in *Massachusetts University for urban development* (Fabos and Caswell, 1977) and ARIS in Australia for environmental evaluation and planning (Cocks and Walker, 1980). Other examples are *M&S Computing* (later *Intergraph*) and *Environmental Systems Research Institute (ESRI)* which emerged as the leading vendors of GIS software (Antenucci et al, 1991).

In 1981, ESRI released Arc/Info, a standard package which ran on mainframe computers (ESRI, 2001). As computing power increased and hardware prices plummeted in the 1980s, GIS became a viable technology for state and municipal planning (Harris and Elmes, 1993). In 1992, ESRI released ArcView, a desktop mapping system with a graphical user interface that marked a major improvement in usability over Arc/Info's command-line interface (ESRI, 2001). Other current systems and software, which mainly developed in the 1990s, are CARIS, IDRISI, SAGE, ILWIS, ALES and many others that could be installed on personal computers (Makhdoum, 1998). In the late 1990s, GIS was being adopted slowly on the sub-municipal level by different organizations and community-based agencies. The development of ArcView for Microsoft Windows and ArcIMS, which enables distributed mapping and spatial analysis over the Internet and eliminates many of the hardware and licensing expenses of a full software package, has increased the availability of spatial data to marginalized and under funded groups. Although access to both GIS software and spatial data sets has improved, the adoption of GIS as a planning or research tool still represents a significant commitment by community organizations (Brown, 2001).

Since 1970, GIS has been implemented in many parts of *Landscape Planning*, from assessment to research to coordination, but its real impacts on different levels still need to be studied. To formulate a meaningful model for GIS-based planning, the factors that contribute to locating the resource in question must be defined carefully and specifically. This process can range from simply identifying contributing variables based on intuition or experience, to statistically analyzing measured variables to identify the most significant ones. Once identified, some critical variables may not be appropriate for GIS analysis. Each factor must also be considered from the perspective of GIS data availability, source scale, accuracy, applicability, and special extent. These considerations are more difficult to accomplish than they may seem.

After introduction of GIS software, especially LUPIS, IDRISI, Arc/Info and ArcView in Iran, some GIS-based environmental evaluation and planning projects have been conducted. In 2002, Makhdoum et al. introduced a GIS-based approach, which has been used for the preparation of land use plans for some areas on a regional scale[2]. These projects have been mainly conducted in the *Ministry of Agricultural Crusade, Forests, Rangelands and Watershed Organization* and the *Department of the Environment*. Currently, many Governmental and private organizations have started using GIS software. However, there is little knowledge about the real benefits or accuracy of output data. In fact, serious problems may arise, because of using low accurate data or inappropriate organization, management and analysis of information in GIS-based planning.

[2] Land use planning of Karoon river basin in the upper part of Karoon 2 & 3 Dam in Khuzestan Province (1999, Scale:1;50000), land use planning of Lordegan river basin in Charmahal & Bakhtiari Province (2000, Scale: 1:50000), land use planning of Mardanghomchai river basin (Arasbaran forests) in Azerbaijan Province (1997, scale: 1:50000, 2000, scale 1:20000)

2.2 Land use planning and natural resources management in Iran

2.2.1 Comprehensive spatial planning

Like in most developing countries, the history of *Land use planning* in Iran started with traditional sector planning in the 1940s. The main goal was to achieve higher economic benefits through efficient utilization of the land resources, labor forces and market needs in the form of sector plans (like mining, agriculture, forestry, etc.). The need for a nation-wide planning and management system first came into consideration in 1936 by the establishment of the *Economic Council* for proper socio-economic growth of the country. It changed later (1946) to the *Supreme Planning Board*, which prepared the first seven-year development plan bill of Iran (1948). In 1974, spatial planning was initiated in the new established *Plan and Budget Organization* by establishing the *Bureau of Spatial Planning*. However, it only started to be practiced after 1985 when some environmental evaluation and planning projects were implemented. In 2000, this organization changed to the *Management and Planning Organization (MPO)* which should pave the way for integration and consolidation of macro planning and management in the country and prepare the ground for the achievement of cultural, social, and economic development plans. Currently, the new *Bureau of Spatial Planning, Sustainable Development, and Environmental Affairs* of the MPO is responsible for comprehensive spatial planning in order to coordinate the various land use demands at different administrative levels in the context of the overall concept for spatial development of the country. MPO is responsible for spatial comprehensive planning in order to coordinate the various land use demands at different administrative levels in the context of the overall concept for spatial development. According to MPO, spatial (land use) planning has three levels: National (supposed to be completed in 2003, but still in progress), Regional and Local.

Spatial planning has experienced numerous ups and downs in the past years. Since 1998 and during the third development plan (2000-2005), MPO made efforts to formulate the so-called *Spatial Planning Document* of the country. Currently, spatial (land use) planning is one of the main pillars of the *20-Years Development Perspective* of Iran, but it has also been given special attention under the fourth development plan (2005-2010). The Government has assigned the task of preparing the spatial planning documents on national, provincial, and local levels during the forth-developing plan (2005-2010).

However, despite a real progress in using modern techniques (e.g. GIS & RS), there remain some shortcomings to overcome. For instance, there is no comprehensive environmental information system and appropriate methods to monitor the environmental issues and consequences of these plans. There is also insufficient attention paid to consider public participation or environmental aspects in developing the macro-economic policies. The first *Millennium Development Goals report of Iran* (MPO, 2004), declared that ensuring environmental sustainability (i.e. integrating the principles of sustainable development into country policies and programs and reverse the loss of environmental resources) has been fairly considered with a fair national support, but the existing monitoring and evaluating capacity is weak[3]. Thus, the *Spatial Planning Document* (2005) of Iran has given top priority to ecological sustainability - as a major prerequisite to the sustainable development - in the process of spatial planning.

The lack of spatial planning and intercooperation led to an inappropriate design and execution of the related plans for agricultural development, nature conservation, watershed management, forestry or grasslands management by the responsible organizations across the Caspian Region. Most of the time, these plans have a lot of overlays, which again increase the conflicts among the mentioned organizations and negatively affect the planning results. In fact, most of the mentioned plans have to either focus on gaining volunteer participants by providing short-term financial supports or use the law to force the aimed community for cooperation that could neither provide a sustainable environment nor improve the economic conditions of the poor villagers.

2.2.2 The Iranian framework method for environment-based land use planning

The principles of ecological land use planning in Iran were introduced first in 1974 in the *Nature Conservation Institute of the Faculty of Natural Resources at the Tehran University* (Yakhkeshi, 1974). Makhdoum developed a systematic knowledge-based approach for environment-based land use planning in the 1980s to ensure environmental protection and to achieve sustainable development in the spatial planning system of the country. However, it only started to be practiced after 1985 with the implementation of some environmental

[3] For data gathering, quality of survey information , statistical tracking, use of data in policy making, monitoring and evaluation

evaluation and planning projects by Governmental organizations. It has been widely accepted by the Governmental and by private organizations for land use planning in Iran.

The current method for environment-based land use planning has been developed from a quite analogue approach to a semi-automated computer-based one, but with the same principles and procedures (Makhdoum, 2002). In this method, the ecological and socio-economic capabilities of the land are determined to suggest the best alternative for future development of a region, based on the national and regional priorities and in a sustainable manner (see Figure 8). The output is an integrated plan, which determines the areas and spatial distribution of the main land uses and can be used as a guideline for comprehensive spatial planning in a watershed.

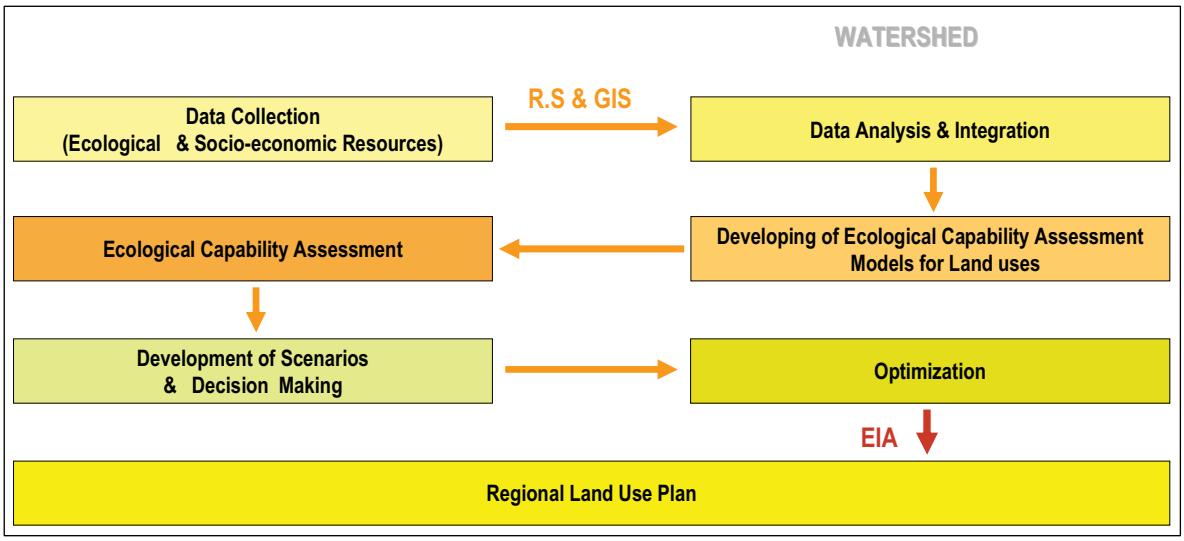

Figure 8: The current approach of Land use planning in Iran (after Makhdoum, 1988, 1993& 2002, designed by Nouri)

To achieve this, a complex set of ecological and socio-economic data[4] is collected and then processed to produce the needed data layers. In data analysis and integration stage, necessary data layers for the planning process are produced and then integrated to delineate the map units. Based on Makhdoum (1993), each map unit represents a part of land in which, the characteristics of the physical resources (i.e. land form, slope, altitude, geographical aspects and soil) and vegetation cover (biological resource) are more or less homogeneous. It is assumed

[4] These include topographic maps, aerial photographs, satellite images, thematic maps and attributive data such as geology and earthquake risk, soil and potential erosion, climate; surface and underground water and water quality, vegetation type and plant inventory; wildlife habitats and inventory; protected areas; current land uses; settled and administrative areas; infrastructures, and tourist sites in the same scale. The socio-economic data set include population number and density, sexual ratio, age classification, employment/unemployment rate, per capita and sources of income, illiteracy rate, health, number and type of livestock, agricultural production, small/large industries, touristy/archaeological/holy sites, environmental pollutions; disturbances; degradations, etc.

that this part of land with its special climatic conditions represents an ecosystem with a consent water regime, soil type, vegetation type, and wildlife species. Therefore, he considered such arbitrary map unit "*suitable*" for the process of land use planning (Makhdoum, 1993). Using Mc Harg's overlay technique (1964), the classified maps[5] of Slope degree, Altitude classes, Geographical aspects, Soil types and Vegetation (type and density) are integrated manually or digitally to prepare the map of planning units, which are then identified with a dedicated code. Other ecological data (see table 1), including surface and underground water reserves, climate type, and wildlife species in company with the socio-economic data are determined and saved for each work unit in a database.

Table 1: An example for the ecological characteristics table of a map unit (after Makhdoum, 1993)

Unit code	123456
Slope (%)	0-5
Altitude class (m)	0-100
Geographical Aspect	plain
Soil type & Bedrock	Compisoil, Deep, limestone
Vegetation Type /Community (dominant)	Box tree & Hornbeam with 4m3 annual growth
Vegetation Density (%)	65-75
Water reservoirs	Permanent river with 0.8m3 annual discharge
Wilde life species	Wild boar
Climate	Humid
Erosion potential	Weak (0-25%)

In the next stage, a set of models are developed for ecological capability assessment of the work units for the current or alternative land uses. These models represent the optimum ecological conditions for an effective and sustainable kind of land use. In 1985, Makhdoum developed a set of qualitative verbal models for eight kinds of common land uses[6] in Iran. The models have different classes, which show the degree of suitability from the best (the first

[5] For example, the elevation classified map may have 11 classes (0-100m as class1, 100-200 class2, 200-400 class3, 400-600 class4, 600-1200 class5, 1200-1800 class6, 1800-2200 class7, 2200-2600 class8, 2600-3000 class9, 3000-3400 class10 and >3400m above see level as class11. In fact, this classification shows the maximum and minimum elevations for vertical distribution of dominant plant communities in Iran

6 This set of models includes 7 capability classes for forestry and afforestation, one class for ecological protection/conservation, 2classes for ecotourism (with & without facilities), 2 classes for urban/industrial/ rural /militaristic/infrastructures development, one class for aquaculture, 7 classes for agricultural activities (including: irrigated farming, animal husbandry, agricultural industries, poultry production, apiculture, silkworm culture, horticulture and rain-fed farming) and grassland management (cattle/sheep/goat raising) and 6 classes for watershed management activities (including 4 classes for flood and erosion control and 2 classes for sedimentation control measurements)

class) to worst (the fourth or fifth) ecologic conditions. For instance, the first class model for agricultural activities defines the best ecological characteristics of a work unit as follows:

"Climate: form Mediterranean to very humid, annual temperature: between 18-30 degree centigrade, access to the water supply: between 6000-10000 m3/ha/year or more, slope: between 0-5 percent, relative humidity: between 40-100 percent, soil salinity: between 4-8 micro Mohs/cm, potential to the soil erosion: 0-25 percent, soil evolution: completely developed deep soils, soil pH: 6-7, soil granularity: very small to small, soil depth: 180 cm or more, soil fertility: very good, soil drainage: perfect, soil hydrological groups: groups A and B, soil texture: loamy-clay-sandy or loamy-clay or clay-sandy or clay, Geo-hydrology: class 10 , degree of protection: non-protected areas, conservation value of the plant species: non-protected species, Habitat(s) type and quality for wildlife species: including both, sensitive (only riversides) and resistant (terrestrial) habitats, excellent "

Among all models, the special model for ecological conservation has only one class. In fact, it only declares the general conditions, which shows the high necessity of the land for conservation. These are including:

"Habitats, which are under sever anthropogenic uses, or are valuable for scientific researches, or are highly susceptible to the erosion; landslide; flooding; drought or pollution, or have unique biodiversity elements, or IUCN rare species, or are unique, or have high conservation value as Gene Bank, or have unique geologic or geomorphologic structures, or unique scenic values, or virgin/intact (natural) conditions, or high number of wildlife species, or endemic/regionally/nationally important species, or are unique on a regional/national scales, or migration corridors for wildlife species, or have hydromorphic soil, or act as ecotone for wetlands/pounds/lakes, or have important archeological/historic / national monument, or have a slope degree more than 70 %, or have anthropogenic value, or are water reservoirs, or have endangered species, or have special conditions that any anthropogenic use may led to a huge catastrophe, or have important fauna and flora."

These models are rather general and developed for land use planning on the national scale, but they may be specified further for the regional scale. For GIS application, these models were transformed to a set of linear stochastic models (Makhdoum 2002).

The process of ecological assessment includes comparing the ecological characteristics of each unit with those in the model. The results are presented in a map that shows which map

unit has optimum, moderate, low or very low ecological capability for developing each land use.

The results of the ecological evaluation process and field visits, as well as, the socio-economic priorities and needs of the area will be considered to develop scenarios for future development of the area. In the prioritization phase, the best alternatives among current and potential land uses for all of the work units are selected based on the procedures and goals of sustainable development. The eligible alternatives are those, which are ecologically sound and could bring sustainable benefits (ecological and socio-economic) for both, humans and nature.

In the GIS-based approach, some efforts have been made for a model-based socio-economic assessment to calculate some weight scores for anthropogenic degradations (D), current situation and capacities in terms of production (?); employment and incomes (A), future needs (F) and, social/economic/cultural potentials (P) of the human society for each work unit[7] (Jafarzadeh, 2002). Unfortunately there are no further suggestions given to combine these socio-economic scores with the ecological capability in order to decide about the most appropriate current or alternative land uses in the planning area.

In the optimization phase, the compatible land uses are arranged for the area and the final pattern is presented in a map. This land use map can be presented within the hydrologic boundaries (watersheds/sub-watersheds) or following administrative areas (Makhdoum, 1988-2002).

Since the environment-based land use planning has been introduced in Iran it has been further developed from a complete analogue process to a semi-automated one in which, GIS software and Remote Sensing techniques are used, not only to increase the speed but also the accuracy of the planning process.

In the following section, the focus is driven on different aspects of this approach in terms of its advantages and restrictions.

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[7] The socio-economic models are as follows (Jafarzadeh, 2002):

$D = d_1 S_1 + d_2 S_2 + \ldots + d_h S_h$, $A = a_{h+1} S_{h+1} + a_{h+2} S_{h+2} + \ldots + a_i S_i$, $F = f_{i+1} S_{i+1} + f_{i+2} S_{i+2} + \ldots + f_j S_j$

$P = p_{j+1} S_{j+1} + p_{j+2} S_{j+2} + \ldots + p_m S_m$

in which, S_1 to S_m are the socio-economic factors and $d_{1\ldots h}$, $a_{h+1\ \ldots\ i}$, $f_{i+1\ \ldots j}$ and $p_{j+1\ldots\ m}$ are the weighting coefficients for each factors

2.2.3 Forestry planning and forest management responsibilities

The utilization of forest resources has a long history and started around 4200 years B.C in Iran (Hejazi, 1962). However, as a construction material wood was first widely used by Achamedians (550 BC) for constructing houses and boats and making weapons. Therefore, conservation of the forests became an important duty of the kingdoms and governments early in Iranian history. Based on Sperber (1994), Iranians were the first nation, who had a special organization for conservation and management of the forests.

At first, human communities used forests for cattle-raising; hunting, and timber or fuel wood extraction but later, people started converting the forests to the arable lands and pastures. By the 18th century, forests mainly belonged to the king and royal families, who rented or affiliated them to the nobles and local landlords. It was them who undertook the management tasks for conservation, hunting, cattle-raising and timber extraction. At that time, a large part of the Caspian forests was destroyed to provide money for the wars between Iran and Russia (18th century) or to compensate the prodigality of the Qajar Kingdom (Yakhkeshi, 2005).

In the 19th century, the Iranian Government began vending parts of the royal forests and pastures to private owners in order to compensate the lack of budget, but most of them were refunded later as tribute or tax. It should be mentioned here that the term of "Government" at that time was quite different from what was elaborated later, especially after constitutional revolution at the end of the 19th century, which led to the establishment of the parliament and government departments in a semi-democratic manner but under supervision of the king. In 1872, the Government began to rent its "industrial forests" to foreign companies from England, France, Greece, and Russia for timber extraction and developing new farmlands.

At the beginning of the 20th century, the Government started to buy back and manage those forests, which seemed to be adequate for industrial timber production in the north of Iran. In 1919, the first forest management office was established in the Ministry of Agriculture and Public Affairs with the mission to survey the public and private forests, to prohibit land conversion and to manage the process of timber extraction. The office was further developed during the following decades, first by recruiting foresters from Switzerland and Germany and later by educating Iranian experts (e.g. Mr. Karim Saee). It was transformed into the F*orestry Department* (1937), the *Forest Agency* (1949) and the *Forest Organization* (1965) (Yakhkeshi, 1981& 2003). In 1956, the first forestry plan for the Veysar district, a part of the Caspian forests, was prepared (Makhdoum, 1998).

The planning process was further developed during the next decades by preparing watershed management plans to control the sedimentation in the catchments' area of dams, agricultural development plans and their related soil capability evaluation studies, geological surveys, management plans for the National Parks, protected areas, and grasslands. In 1964, forests and grasslands were nationalized and the tasks for protection, rehabilitation, and management were affiliated to the *Forestry Organization*, which restructured again in 1972 as *The Forests and Rangelands Organization*.

By approval of the *Environmental Protection Act* in 1974, environmental concerns became an important priority in Iran. After the revolution, it was emphasized again in the Article 50 of the Constitution Law, calling for preventive and remedial measures for the protection and rehabilitation of the environment. In 1996, Iran joined the *International Convention on Biological Diversity* (CBD) and the Iranian Government propounded the Caspian forests as globally and nationally important source of Biodiversity.

Currently, the institutional responsibility for the management of forests lies with the *Forest, Rangeland and Watershed Management Organization (FRWO)* of the *Ministry of Agricultural Crusade (MAC).* At the provincial level, the FRWO elaborates and conducts forestry plans, manages the relocation of livestock herds, which have encroached into forest areas and implements general conservation and forest rehabilitation measures. Private companies mainly undertake the timber extraction under the supervision of the FRWO which is also responsible for the management of the grasslands and watersheds.

Meanwhile the *Department of the Environment (DoE)* is responsible for the management of Protected Areas such as National Parks, Protected Areas, Wildlife Refugees, Natural Monuments and Wetlands, the protection of wildlife species and habitat destruction as well as for monitoring and prohibiting environmental pollutions in urban and industrial areas. On provincial and township levels, the MAC departments conduct and implement agricultural and rural development activities.

In a general view, forestry planning in the Caspian forests still follows a complete top-down sectoral approach, in which timber production is the ultimate goal. Economic aspects always play more important roles than ecological or other socio-economic functions of the forests across a watershed. It means if a forest patch could be used for industrial timber production, it should and would certainly be programmed for such a purpose, without enough attention to the other important functions like protecting the soil, adjustment of the water regime or sup-

porting the livelihood system of the so-called "forest-dependent" rural communities on a local scale. In spite of the Government view on the forests as a "Public Asset", the villagers still follow their traditional borders and common right of ownership for domestic uses that are normally encountering or competitive to the FWRO's protection, rehabilitation and logging tasks. In fact, the both socio-economic needs and potentials of the rural communities are neglected in preparation and implementation of the forestry plans. Most of the time, villagers have to face sudden decisions of the local authorities, which restrict their access or right of use, but facilitate plundering "their forests" by the private contractors. This led to a huge conflict among FWRO and rural communities across the Caspian Region. Even, the establishment of a few "forest cooperative companies" by FWRO failed to gain the trust or to increase the level of community participation in implementation of the forestry plans.

2.2.4. Consideration of local community interests

Investigations that deal with the anthropogenic pressures on the natural environment and that take the needs of the local people into consideration to combat land degradation (especially forest destruction) do not have a long history. It began with studying the socio-economic aspects of the forestry plans and their possible impacts on the affected communities in the Caspian Region.

In 1977, Yakhkeshi investigated the main reasons for forest destruction in the mountain forests of the Caspian region. He resumed that the harsh environmental conditions for cultivation and animal husbandry accompanied by an ineffective traditional living system, had led to the poor economic conditions of the rural society, which he identified as the main reason of forest destruction. Furthermore, he stated that villagers were completely dependent on the forest resources for firewood collection, charcoal production and livestock grazing, in an inappropriate but destructive manner. However, he mentioned that such areas had great potentials for environmentally-sound livelihood activities, especially concerning agro-forestry, cultivation of the medicinal plants, forage production and semi-intensive cattle-raising, which could be planned and implemented by close cooperation of the rural communities. During 1975-1977, he planed and implemented a pilot-project to introduce new techniques for increasing the agricultural and dairy products in some villages of Yakhkesh area in Mazandaran, north of Iran. Using a propagation program, this project intended also to increase the environmental aware-

ness of the rural society for wise use of the natural resources and for conservation of the forests.

In 1980, the former *Forest and Range Lands Organization (FRO)* started a pilot phase for integrating socio-economic investigations into the feasibility studies of their forest management plans. These studies aimed at finding and then solving the main socio-economic problems of the rural societies in the management areas. The results of these studies showed that the FRO was not able to handle this task within its routine programs. Therefore, the FRO suggested 3 alternative plans, which should be integrated into the forestry plans: A special plan for promoting the establishment of rural cooperative companies for forest management; A special livestock management plan to exit livestock from the forest areas; And an employment program to create new job opportunities for the rural communities of the Caspian region. However, these programs did not come into practice before 1989 (Saffari, 1994).

In 1991, Rostami investigated the negative impacts of the livestock grazing and the livelihood system of the cattlemen in northern forests of Iran and concluded that the traditional cattle-raising system was not compatible with the modern forestry plans, especially the logging activities since it could negatively affect natural regeneration. To solve the problem, he suggested that the livestock should be exited from the forests by introducing economic alternatives like semi-intensive animal husbandry and genetic improvement of the livestock or by providing new job opportunities to the cattlemen.

Shaeri (1999) developed a community-based propagation system for the FRO livestock management plan. He concluded that the villagers and cattlemen prevented forest conservation and rehabilitation activities, because they had never been invited to assist developing such plans. Therefore, proper mechanisms should be developed for a participatory conservation and management of the forests. She came to the conclusion that establishing cooperative companies was the best alternative in order to stimulate the public sentiment of ownership, which is quite necessary for active participation and volunteer collaboration in rural areas.

Although, the current socio-economic system of the rural areas in the Caspian mountain forests is known as “traditional” and “ineffective”, Shaditalab (2000) stated that social relations, priorities and needs did change slowly but continuously during the last decades. For instance, the dependency of the livelihood system on the forest resources changed. Nowadays, forests are rarely used for providing food, because rural markets are getting more and more influenced by new products from the adjacent cities. For example, the rate of self-production and

consumption of the main agricultural products such as wheat and rice started to decrease in the rural areas).

Nevertheless, Dashbolagh (2000) believes that the traditional livelihood system is still destructive. He estimated the total damages of each rural family to the forest resources in the Golestan Province, eastern part of the Caspian Region. The results show that each family has at least 53 livestock and the per capita consumption of firewood and timber is 45.98 and 2.93 cubic meters/year, respectively. Forest conversion has been estimated to be 4.6 ha/year for each family. Thus, the total damages have been estimated to be around US$ 1972 per year and family.

Malati et al. (2000) studied the socio-economic and cultural conditions of the cattlemen in Mazandaran province and came to the conclusion that increasing the level of environmental awareness, education and income of the cattlemen could decrease forest destruction.

However, Mahmudpour (2000) who investigated the history of human settlement in the Caspian forests came to the conclusion that in spite of the Government's propagation programs, the level of social awareness of the importance of natural resources for protecting soil and water or the necessity of sustainable use is still low. Generally, the rural societies show a low level of trust on both, governmental programs and staffs. Illegal activities like logging or forest conversion result from social problems like poverty, lack of awareness and search for better livelihood alternatives. Thus, possible measures should be developed by considering the cultural, social and economic conditions of the target communities.

Mehrabi and Abdollahpour (2000) investigated the socio-economic conditions of the forest cooperative companies in the Caspian Region. These companies were a part of the FWRO strategic plan for promoting public participation in the conservation and management of the Caspian forests, and had been started in the 1990s. So far, most of them had not been able to properly fulfill their tasks, due to the lack of monitoring and weak capacity building on both government and community levels. Under a proper management regime however, they can play an important role to improve the social conditions and to organize the rural society for conservation, rehabilitation and timber extraction.

In 2001, Khadem studied the impacts of the FWRO livestock management plans on the cattlemen across the Caspian region and concluded that the total income showed no change, while the unemployment rate among the target groups further increased. So far, cattlemen have always been considered as the main responsible group for forest destruction in northern

forests by the Governmental organizations. Opposed to this, cattlemen themselves do believe that wood smugglers and private companies play the main role.

In 2001, Yakhkeshi submitted a demonstration project to the UNDP-GEF[8] for the conservation of the forests and the improvement of the economic conditions of the villagers in the Yakhkesh area (Mazandaran province). He suggested that increasing the level of environmental awareness as well as the total income of the rural society, would be the main factors to combat anthropogenic forest destruction in the mountain areas. He further stated that both could be achieved by training and propagation programs, establishment of multi-purpose rural cooperative companies, improvement of the traditional cultivation systems, afforestation of degraded forests, establishment of semi-intensive animal husbandry stations and of agroforestry activities in the sloppy farmlands for timber, fruit and forage production and finally, introducing alternative energy supply like biogas, as well as ecotourism and aquaculture.

However, only some of the project's activities were executed during 2001-2005 by financial supports of the *GEF Small Grant Program (SGP).* The results of the project show that the total production of wheat and barely could be increased from 0.6-1 ton/ha up to 3-5 tons/ha by proper utilization of fertilizers, pesticides and genetically-improved breeds. At the same time the total income may be increased up to 200 percent (Mirrajabi 2004). In contrast to many others, this project was completely successful in gaining the community supports and more than 90 percent of the rural communities participated in establishing a multi-purposes cooperative company and implementing other project activities.

Amuzad (2003) studied the socio-economic conditions of the rural communities in mountain areas and its impacts on the forest resources in a part of Mazandaran province. His study shows that socio-economic conditions, especially illiteracy and poverty, directly affect the level and intensity of forest destruction in the rural areas. The major part of the forest conversion happened in the adjacent areas of the villages, mostly during the first years after Islamic revolution (1978 to 1980), when control measures went down to a minimum level. The implementation of the forest management plans helped conserving the quantity more than the quality of the forests. Land ownership turned out to be another important reason for ineffective cultivation, because the farmlands are going to become smaller and more separated, when they are transferred to the next generation by inheritance. Thus, the total income of the villagers in mountainous areas is less than both provincial and national averages. A great part of the rural society believed that forestry plans brought no benefits, but increased their problems

[8] United Nations Development Program – Global Environment Facility

for domestic uses of the forests. However, they were eager to participate in those governmental programs that do not only aim at conserving the forests, but also at improving their livelihood system. He suggested that the current forestry plans should be improved in a more integrated and sustainable manner, based on the cultural characteristics and domestic knowledge and experiences of the rural communities.

All these investigations show the importance of the socio-economic analysis for improvement of the current preparation and execution process of the forestry plans. However, they mostly tended focusing more on the "impacts" within the boarders of the forestry planning, than presenting a "root-cause analysis", in which the so-called socio-economic problems or impacts could be also tracked within or among other planning disciplines like spatial planning, watershed management, animal husbandry, agricultural development or urban development, etc. with a more integrated and holistic view. Unfortunately, investigators paid weak attention to the potentials of the rural society as well as the current government programs, which might be used to improve the current system. Forest loss in the Caspian region is a mutli-dimensional anthropogenic problem and solving it needs a multi-dimensional procedure with close cooperation of the all stakeholders in the both governmental and non-governmental related sectors (see Figure 29, chapter V). However, the weak cooperation among research institutes and governmental organizations led to a regrettable situation in which most of such results and suggestions are never come into the practice.

2.2.5. Advantages and restrictions of the Iranian approach

❖ Advantages

Attention to the ecological feasibility, as a basic need for sustainable utilization of the land, is the most important aspect of this planning approach. It uses nearly all the available data on both physical and biological resources in a systematic and holistic way. These had hardly ever been taken into account in the previous development plans of Iran. The capability assessment models are able to successfully use the results of long-term research and practice on different aspects of land utilization across the country. By means of GIS and Remote Sensing techniques, this process can be in principle implemented faster, with a better accuracy and quality. It is possible to visualize and then compare current situations and possible scenarios for future

development of an area, which helps both, the decision makers and the society to get a better understanding of the results.

❖ Restrictions

Anyhow there are quite a few restrictions to be taken into consideration (see Figure 9):

➢ Formulation of goals and objectives

Roberts (1975) suggested that there are a few very broad and fundamental goals toward which land use planning should be directed: (i) equity – a fair and just consideration and treatment for all those affected by a plan or course of action; (ii) efficiency; and (iii) choice – the creation or maintenance of the greatest number of possible options for the individuals. Woodbury (1966) suggested the general objectives for land use planning include: livability, efficiency, amenity, flexibility and choice, minimum harm to the natural communities of plants and animals, optimum use of resources, and public involvement in the planning process. Based on Makhdoum (1988 & 2002), the land use planning in Iran directs also toward such general goals and objectives. On a large scale, such general goals may be relatively easy to identify and agree upon. However, in a land use planning program on the regional and community scales, such general goals must usually expressed in more specific terms in order to fashion effective plans and to eventually evaluate the extent to which the chosen goals are being achieved. Hall (1975), for example, identified three levels of goals: the very generalized which he calls "goals", the more specific which he calls "objectives" and the very detailed which he calls "targets". Regardless of different terminology, it is clear that great effort may be expended on developing extensive statements of goals and objectives, where multiple land uses and public services are being planned. A quick look at the Iranian planning approach reveals that the planners use the same "general goals" for preparation of the land use plans in the different bioclimatic regions or on different spatial scales. In a totalitarian society like Iran, goals and objectives are mainly specified by the rulers or planners than the society. For instance in the mountain areas of the Caspian region, a wide variety of goals and conflicts between goals came to the surface from the traditional agriculture and animal husbandry system of the rural communities with the previous and current programs of the governmental organizations (MOAC, FRWO and DOE). Many of them may not be easily resolved or resolved at all. In fact, a wide variety of tools or methods may be utilized in a more democratic manner through an interaction process by involving all of the stakeholders. What one would hope to

achieve – in addition to identifying generally agreed upon goals – is explicit recognition that multiple goals do exist, an identification of any conflicts between those goals, and resolution of the conflicts where possible. Where conflicts cannot be resolved, the decision-makers should be provided with enough information so they are cognizant of the unresolved conflicts. As a completely top-down process, the Iranian planning approach fails to gain stakeholders' participation for formulation of the generally agreed upon goals, especially on regional and community scales.

- Data quality and quality of the inputs and outputs

As it was pointed out by Volk and Steinhardt (1998), procurement and preparation of the basic data is an essential phase of *Landscape Planning*, which normally take at least half of the whole time spent on such investigations. Data should always be gathered in relation to the planning aims, and their accuracy must be verified. Time related series of data (e.g. climate data) have to be complete, spatially representative and should cover a couple of years. One important aspect is that the data have to be suitable for the scale of investigation in terms of their spatio-temporal resolution. Otherwise, results (e.g. the derivation of indicators) may be produced which are incorrect, especially if several different data layers are used for an integrated analysis. Moreover, the form of the required data and their availability is often insufficient and the user has to process them further. Thus, there is a huge need for standardizing comprehensible methods for aggregating and generalizing the data.

However, apart form a few investigations (Fallah-shamsi & Darvishsefat, 1998), estimation of data accuracy for input and output data is not very common in Iran and access to the accurate spatial and temporal information is sometimes impossible. Some data may be quite up-to-date (e.g. satellite images9), but are not always accessible in a suitable scale, while others are old (e.g. old aerial photos and topographic maps, vegetation type maps) or do lack in the needed area (geological formations, soil groups) or period of time (aerial photos, national censuses data, climatic or hydrological data) scale10. The environment-based land use planning of Iran

[9] The current landuse map and some other thematic maps are usually prepared from satellite images. The results however are highly dependent on the needed data pre-processing (geometric and atmospheric corrections) and on proper fieldwork, which are usually neglected due to the lack of budget or access to the needed software.

[10] Due to the lack of sufficient budget or time for detailed surveys, some large-scale thematic maps like geology, soil or vegetation type maps, are prepared by re-sampling of small-scaled maps without or with a few field works to check the boundaries. This also decreases the accuracy and quality and may lead to false results and misinterpretations. The national censuses, as the main sources of socio-economic data, are taken every 10 years in Iran. Some of the information like the number of inhabitants can be upgraded, but other information needs detailed surveys and field works, which may be neglected due to the lack of budget or time.

does not offer the flexibility for working with such limited or non-accurate data. Any error may largely affect the results, without being easily detectable afterwards (see Figure 9).

The procedures for data input, transformations, establishment and management of the database are important as well. Integrating area-wide and point source data (socio-economic, etc.) or quantitative and qualitative data are complex tasks which should be done with profound knowledge and experience. Except a few examples, establishment of the metadata are not properly considered for the both input and output data layers in the planning process, especially in those projects that are prepared by the private consultation companies.

A lack of methods for the verification of the planning results or for monitoring their implementation is the most important weakness of the planning procedure in Iran. However, such evaluation is quite necessary to detect the problems and areas of inaccuracy and to find solutions for the enhancement of the methodology, in both theory and practice.

- Scale, reliability and adequacy

Several studies in the environmental sciences deal with the hierarchical organization of ecosystems (O'Niell et al. 1986, Burns et al. 1991, and several others). Awareness and appropriate treatment of such hierarchies is important for data compilation and choice of adequate indicators. An increasing hierarchical order is mostly accompanied by an increase in complexity. In ecological planning, the spatial units (landscape units) which are supposed to represent homogeneous ecological conditions are also organized in spatio-temporal hierarchies, which can be approached at micro-, meso- and macro-scales (Steinhardt 1999, Steinhardt & Volk 2000). Problems do result from the transformation and transfer of information from one more or less homogeneous spatio-temporal scale level to another with higher heterogeneity. This scale problem is true for both, 'top-down' and 'bottom-up' approaches. Hence, both have to consider procedures for generalization that are suitable for the respective scales and differences in complexity and heterogeneity.

According to Herz (1973), homogeneity can be achieved at each scale by agglomeration or generalization of characteristics. Thus, it should be made clear whether the data about dominant conditions and processes are used or whether features of heterogeneity are also considered (Kroenert et al. 2001). According to Makhdoum et al. (1985, 1998 & 2002), the ecological assessment models of Iran are rather generalizing. Results need to be specified and

adapted to the different ecological conditions of each region across the country. However, this does not seem to be clear for most users in the Government or in private sectors (Nouri, 2005). To formulate a meaningful model for GIS-based land use planning, the factors that contribute to locate and assess the resources must be defined carefully and specifically. This process can range from experience based identification of contributing variables to statistical analysis of measured variables to identify the most significant ones. Once identified, some critical variables may not be appropriate for the GIS analysis. Each factor must thus be considered from the perspective of GIS suitability concerning data availability, scale, accuracy, applicability, and spatial extent.

Both, general and GIS-based assessment models of Iran have been developed focusing the assessment of potentials/capabilities for production functions (land uses) rather than the regulation functions of the ecosystems. Landscapes fulfill different functions. On the one hand, there are landscape functions concerning the protection of the functioning of the landscape itself and its related geo-systems: the regulation functions ("internal functions"). On the other hand, such functions occur that are important for the immediate use of society and man: production, carrier and information functions ("external functions"). The permanent fulfillment of these external functions can only be reached by the preservation, improvement and protection of the internal functions (regulation functions). For instance, nature and landscape protection serve as an important instrument in the German approach of "*Landschaftsplanung"* for the preservation and improvement of the regulation functions, which also includes elimination of critical environmental stresses (Mueller & Volk, 2001). In any case, selection and arrangement of the land uses should also preserve the basic ecological processes and functions, which are not properly considered in the Iranian approach.

- Compatibility with other sector plans

As it was mentioned before, the current approach has been developed based on the results and experiences of previous sector planning, especially in the fields of agriculture, natural resource management, ecological conservation, and urban/rural/industrial development. However, it has not been widely accepted by the responsible authorities as a guideline for conducting their planning activities. The main reasons are weak capacity building, legal constraints, low intersectoral cooperation, and even arguments about competences among responsible organizations. The lack of an integrated planning and management framework in catchments areas of the Caspian region, led to a huge degradation of natural resources with negative social

and environmental consequences, e.g. poverty and flood events (Nouri 1999, Yakhkeshi et al. 2005). Without stakeholders' participation in both, planning and decision-making phases, this top-down approach seem very impractical and may hardly reach the planning goals and objectives on the local scale.

- Stakeholders participation in the development, execution and monitoring of the land use plans

The approach tries to be as objective and rational as possible, by integrating nearly all related ecological and socio-economic data in the planning process. However, the results are highly affected by the experience and knowledge of the planners, especially in the assessment, prioritization, and optimization phases. The planners do intend to prepare an 'optimum plan', and then expect that, the responsible organizations and affected communities should adapt themselves to it for achieving sustainable development. However, this often does not happen due to the lack of an implementation mechanism. This approach uses an arbitrary unit for data integration and ecological suitability assessment, which in practice, are not easily detectable or incompatible with the obvious elements of the cultural landscape. Due to missing stakeholder participation, local communities and even Government managers and staffs have difficulties to comprehend the results. Most of the so-called 'land use plans' are currently prepared by private consultants for the related Governmental organizations. Without attention to the stakeholders' demands in both planning and practice, even a perfect theoretical plan will never be able to solve the challenges and conflicts among people and the Government concerning the utilization of the natural resources. The lack of an operational mechanism as well as a monitoring program increases the task overlays and decreases the efficient execution of the current sector programs for protection, wise-utilizations and rehabilitation of the natural resources in a more integrated and sustainable manner. The same situation is also expectable for execution phase of the land use plans, without a detailed operational as well as monitoring program.

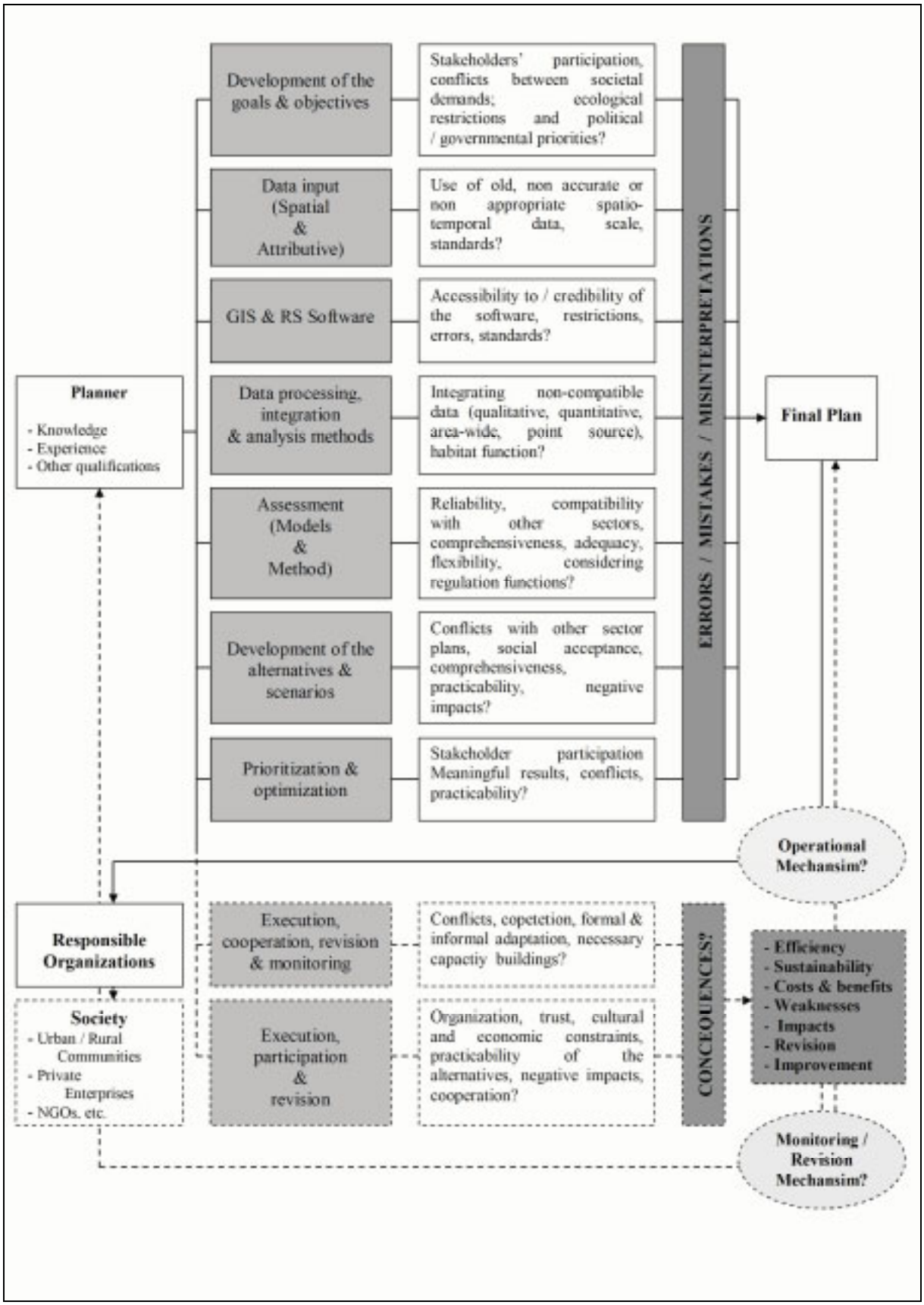


Figure 9: An overall judgment on the current approach for land use planning in Iran. The both theoretical and practical aspects are considered for identifying the possible sources of errors as well as the restrictions. The dashed lines represent those aspects, which have not yet been realized in practice (Nouri, 2005).

CHAPTER III

THE PLANNING PROCEDURE,

MATERIALS & METHODS

3.1 The planning procedure

It is clear that any important decision concerning the future of an area would involve a wide range of issues and decisions. These can be summarized as the interaction between principle future development options and the physical, biological and cultural values and capacities of the landscape as well as demographic, economic and political conditions. The decisions however should not been made by international and national requirements or by government authorities and expert's comments alone but should also involve the local people and their needs and expectations. Consequently, a *discursive planning, implementation, monitoring and revise procedure* is indispensable to achieve a widely accepted, continuous and adaptive sustainable development.

This chapter provides the concept for the initial discursive planning steps (i.e. assessment, occlusions and recommendations) within this cycle (see Figure 10) and describes the respective methods that were used for data collection, processing and assessment in the Yakhkesh Mountain test area.

For this purpose, both communities', as well as, experts' opinions on different aspects of the current frameworks for environmental protection and natural resources' planning and management, which could be directly or indirectly related to the forest loss in the rural areas were gathered. Furthermore, ideas for solutions or alternatives to combat the mentioned problems based on previous and current experiences where collected

The study includes two assessment phases, i.e. an *Ecological Assessment* and a *Community Assessment.* The results of the both are used to fill information gaps and to elaborate the final plan of action. This was achieved by passing through the steps as presented in Figure 11.

The innovative aspects of the suggested procedure can be summarized as follows:

- Developing a bottom-up discursive approach (which carefully exams the current top-down expert's method) for land use / *Landscape Planning* to increase the level of transdisciplinarity and public participation in the planning process
- Introducing nature conservation and landscape management aspects to the current process of land use planning in Iran, which considers a broader and at the same time more operational integrative approach than the common understanding of "conservation" as a type of land use by protection

- Local scale planning with greater emphasize on community participation and practicability in the planning process to enhance the economic conditions of the rural communities through environmentally-sound alternatives and to facilitate the execution of the current Government programs in a more integrated and cooperative manner
- Identifying the restrictions and deficiencies for achieving such goals

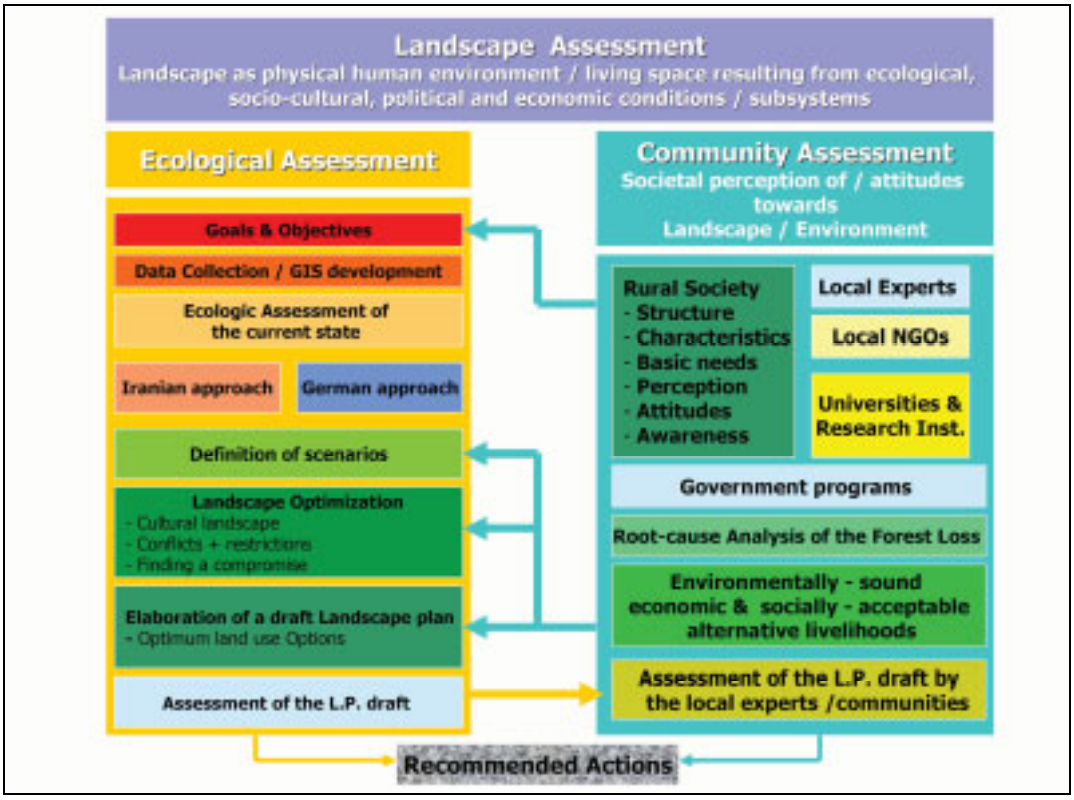


Figure 10: Compiled *Sustainable Landscape Planning* procedure for this study (after Makhdoum, 1998-2002, Steinitz, 1990, and Kiemstedt et al. 1998).

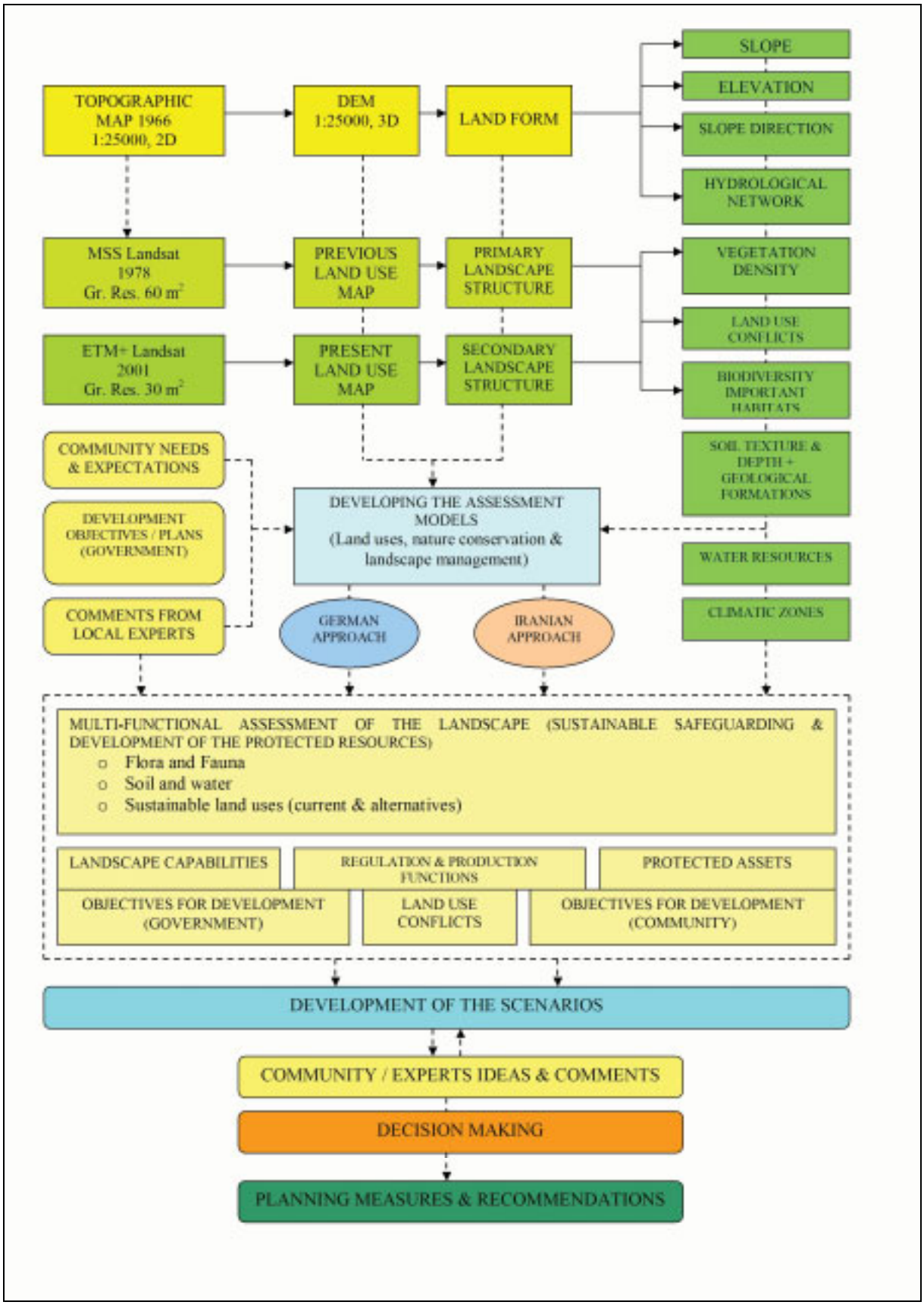


Figure 11: Inputs and outputs of the suggested planning procedure

3.2 Methodology

3.2.1 Data base and data processing

Access to the accurate, up-to-date and reliable data sets is a key factor for successful analysis in any research program. However, in the most of developing countries like Iran, planners can hardly achieve it, especially on the local scales. Since the main goal of this study is enhancing the current approach by means of the available data, we collected nearly all information that is normally accessible from the related plans and responsible organizations or could be produced form other data or by field visits. Due to the semi-long term research background in Yakhkesh area, the access to the data and their accuracy levels seem far better than for other areas in the Caspian region. However, some gaps remained and will be discussed further down.

The following data were collected from the different organizations:

❖ Ecological data

- Topographic maps of the area on 1:25000 scale (2D format) from National Cartographic Centre of Iran
- Satellite images for the years 1978 (MSS Landsat), 1990 (ETM Landsat), 2001(ETM+ Landsat) from Research Institute for Forest and Rangelands (RIFR) in Iran and The Global Land Cover Facility (GLCF) data bank of the University of Maryland USA website
- Soil texture and depth maps, which is produced by MAC Mazandaran from the geological map of the area (scale 1:250,000)
- Ground and surface water supplies
- Climatologic data
- Potential touristy sites

❖ Socio-economic data

- Population, sex rate, educational levels
- Infrastructures, public health
- Number of the livestock, poultry, …
- Cultivation areas and ownership
- Sources and levels of income
- all from 1996 National Census, up to date to 2001 by MPO Mazandaran

❖ Other Data

- Data set of the UNDP-GEF project in Yakhkesh area (2000-2005)
- A part of the data set for the Tirtash-Galugah and Pajim forestry plans in the adjacent areas, which is accessible by FWRO Mazandaran
- 3 M.Sc thesis which were conducted in Yakhkesh area by the Natural resources Faculty of Mazandaran University
- Related scientific papers which are mostly published in Iran

A database of the project area has been established in ILWIS and then in Arcview (ArcGIS) environments for the data processing concerning physical, biological and socio-economic resources. The following data layers have been prepared in GIS for the assessment phases:

- Digital Elevation Model (DEM) of the study area (1:25000)
- Preparation of the landform, geographical aspects (slope directions), slope degree and Altitude classified maps from the DEM
- Previous and current Land use / land cover maps (1:50000) by classification of the Landsat TM and ETM+ of 1992 und 2001 using the topographic map of the 1966-79 as base map in ERDAS 8.7 and ILWIS 3.4 environments. The MSS image for 1978 is not used due the smaller ground resolution ($60m^2$) than TM & ETM+ ($30m^2$)
- Deforestation map among 1966, 1992 and 2001 using post-classification technique from the satellite images in ERDAS 8.7 & ILWIS 3.4 environments
- Geologic formations map, resample to 1:25000
- Temperature and precipitation classified maps
- Settled areas (villages) and access roads using the both topographic map and the Google map view of the area
- Potential sites for eco-tourism activities (including caves, scenic rocky views, waterfalls and Holey shrines) using topographic map and the results of the field visits and UNDP-GEF project

3.2.2 Ecological Assessment

❖ Multi-factors assessment of the ecological suitability for the main land uses

A multi-factors assessment was done by developing some assessment models based on the national ecological assessment models as described in chapter II (Makhdoum1998 and 2001) and the available data were used to produce the following data layers:

- Ecological suitability map for agricultural activities (*i.e. irrigated, rain-fed, horticulture, fast-growing plantations and cultivation of fodder crops as agro-forestry*)
- Ecological suitability map for forestry and afforestation
- Ecological suitability map for ecological conservation

❖ Landscape assessment based on the current approach in Germany

Using the ecological data layers, a landscape assessment analysis was done for preventing soil erosion following the German approach for *Landscape Planning* in Arcview 3.2 and ArcGIS 9.1 environments.[11] The main goal was to adjust the current land uses to the requirements for soil, water and habitat conservation. With respect to the available information, the following questions were considered as general guidelines:

1. Which agricultural surfaces do have high erosion potential?
   (Surfaces with an inclination above 15 %)
2. Which surfaces are suitable for cultivation?
   (Surfaces with an inclination under 15%, suitable soil depth and texture)
3. Which forest surfaces are potentially threatened by erosion?
   (With low canopy cover and high inclination)
4. Which forest surfaces with high erosion potential are located in the proximity of the villages?
   (Within a distance of 1500m to the villages)

The results of this assessment were then compared with the output of the Iranian approach and the final comments are presented as a future development scenario.

[11] It was further elaborated and completed as a sample project during the Spring 2007 ArcGIS training course for PhD students of the nature conservation unit at the Faculty of Forest sciences and Forest Ecology of the George-August University – Goettingen.

- Land use analysis

Since the produced suitability maps had to be compared with the current land use situation on the local scale, the author collected additional ground data, and took photos from the main land features and natural resources characteristics of the area during a field trip in 2005. The GPS was used to take some ground control points to check the location of the villages, the edge of the forest core area, the main roads, the Neka River. Some training samples were also collected from the agricultural areas, as well as from the dense and sparse forests for the related analysis of the satellite images and other geographical data, especially for potentially biodiversity important forest patches. However, the lack of detailed spatial data layers on suitable scale was the main problem towards producing the needed data layers. For example, the so-called soil texture and soil-depth map have been produced from a smaller scale of the available geology map, and then resampled to the 1:25000, which is the only suitable scale for data derived form digital topographic maps. The course ground resolution of the satellite data (Landsat TM & ETM+) also led to producing land use / land cover maps, which would be more suitable for regional planning than for the same purpose on a community or local scale.

3.2.3 Community Assessment

The above-mentioned field trips were also executed to gain information about the local rural society, concerning her structure and characteristics, the basic needs of the people and their perception and awareness of their current situation and the natural environment, as well as their attitudes towards natural resources' planning and management.

The main goal of this *Community Assessment* was to get insight into the ideas of both, local community members as well as local experts, concerning different aspects of the current framework of environmental protection and natural resources' planning and management, which could be directly or indirectly related to the forest loss in the rural mountain areas of the Caspian region. The investigation aimed at exploring the general, as well as, specific views and ideas on the root-causes and main reasons for the forest loss and the degradation of the natural resources. It further intended to collect relevant individual experiences, ideas and critical views with respect to proper solutions and alternatives to combat them.

To achieve this, the author conducted two series of interviews with villagers (60 persons) and local experts (53 persons). The first series of interviews was executed in 2005, and a second one in early 2007, together with a presentation of the results of the *Ecological Assessment,* in

order to get to know local community members' and experts' judgement about the suggested alternatives for appropriate land use and their ideas concerning the different aspects of the *Landscape Planning Draft.*

For both stages, two multiple-choice questionnaires (See Appendix IV & V) were developed following recommendations of the Asian Development Bank (1993 & 1994), one for the local villagers and the other for national local experts and managers. However, due to the lack of environmental awareness and low levels of confidence and reliability among the villagers, the questions and options had to be simplified in a way that they were understandable for most of them, while covering the essential fields of interest.

❖ Questionnaire for villagers

Using a random sampling method, we selected 60 people, who showed cooperativeness for such an interview, including local villagers and cattlemen in the villages of Evlar (13), Pachat (12), Sheikh-mahalleh (3), Metkazin (2), Gahribmahalleh (4), Zelet (4), Pajim (5), Param (5), Parch (5), Samchul (4) and Parkela (3). Due to the lack of information and trust among villagers, it is normally difficult to find proper candidates, who are willing to participate in such detailed interviews. Fortunately, a UNDP-GEF project has been recently conducted (2000-2005) in some of the villages of the Yakhkesh area under supervision of Prof. Dr. Ali Yakhkeshi[12]. This facilitated the interviewing process with the local villagers. The villagers were asked to answer questions about the history of landscape development in the area, their traditional, as well as, current uses of the natural resources, the respective conflicts they had to face, the sources and levels of income they achieved, and the benefits they got from their surrounding natural environment and, finally their basic needs, their expectations and their visions about the future. We also did present them a simple introduction about the research program and its ultimate goals to increase their confidence.

❖ Questionnaire for experts

The interview questionnaire for the experts covers additional topics, which focus more on different aspects of the decision-making, as well as, planning and management frameworks in

[12] The former associated Professor of the Forest Policy and Nature Conservation Institute of the Goettingen University. Due to the lack of budget, only a part of the planned activities could be executed, which are mainly focused on improving the levels of environmental awareness and income by organizing and training of the people, as well as, by introducing the new agricultural techniques such as agro-forestry, semi-centralized animal husbandry, cultivation of fodder crops and pharmaceutical plants and decreasing the consumption of fuel wood by introducing of a pilot Biogas project.

terms of the experts' views. The first part of the questionnaires asks for general terms i.e. the interviewees' personal information (age, sex, education level, working background and job satisfaction), and their opinion about the environmental protection act and its related sub-sets on forest resources, law enforcement, policy and decision-making process in the responsible organizations, the process of planning and management, the implementation of the forestry, land use, livestock, or agricultural management plans and, finally, the role of public participation and the governmental awareness and education programs on them. The second part focuses on the forest loss, its root-causes and possible alternatives or technical solutions to combat it in the mountain areas. In technical questions, the interviewees had the possibility to add their ideas (as “your idea” option) to give more explanation or to remind something important that was missed or should additionally be considered. With respect to the political restrictions, interviewees were free to participate as a “known” or an “unknown” person.

The expert interviews have been made either directly (meetings) or indirectly (via e-mail), whereas all the villagers have been interviewed during the filed visits. The collected data have then been entered into a spreadsheet for further analysis.

CHAPTER IV

THE STUDY AREA

The Yakhkesh Mountains, with elevations rising up to 1,600 m, lies at the junction of the cold mountainous regions of the Alborz Mountains and falls in the high precipitation climatic zone of the Caspian region with an annual precipitation rate up to 1,000 mm. These particular climatic and geographical conditions have resulted in unique landscape diversity as well as in the existence of important forest areas, which can be regarded as representative for the mountain broadleaf deciduous forests in the Caspian Region. The Yakhkesh Mountain area is regionally significant in terms of its unique plant and animal communities. It is also representative for the general threats related to prevailing social, economic and institutional conditions that resulted in increasing degradation of watersheds, and led to huge flood events and their related ecological as well as socio-economic damages in northern Iran.

Most of the following characteristics, maps and histograms that are used to describe the study area have been produced by the author as basic information for the subsequent assessment procedure.

4.1 The physical environment

4.1.1 Topography

The topology of the project site is mountainous, ranging from 600m (in the North-West) to more than 1900m (in the South-East) above sea level. The Mehraban-rood River is a permanent river and its 2 main branches divide the area into the 4 main sub-catchments. Figure 12 shows a 3 D view of the area from the Southeast.

The topographic map of the study area is shown in Figure 13 on a scale of 1:25000, based on the most recent available data in Iran. This is a combination of four topographic maps, which have been produced by the *National Cartographic Center of Iran* in digital format (2 dimensional) on the scale of 1:25000 and another 1:50000 map, which covers the northern and northwestern part of the area.

Based on this classification, the main parts (57%) of the area is in the altitude range between 1200 to 1800 m (see also Histogram 1). This classification follows the altitude profile for the vertical distribution of the main forest communities in the Caspian Region[13]. Figure 14 shows

[13] Querco-Buxetum and Petrocaryo-Alnetum between 0 up to 100 m above see level, Querco-Carpinetum and Parrotio-Carpinetum between 100 up to 700 m, Fagetum hyrcanum with Vaccinio-Fagetum in lower altitude

the classified altitude map of the area, based on the classification method of Makhdoum (1988-2002).

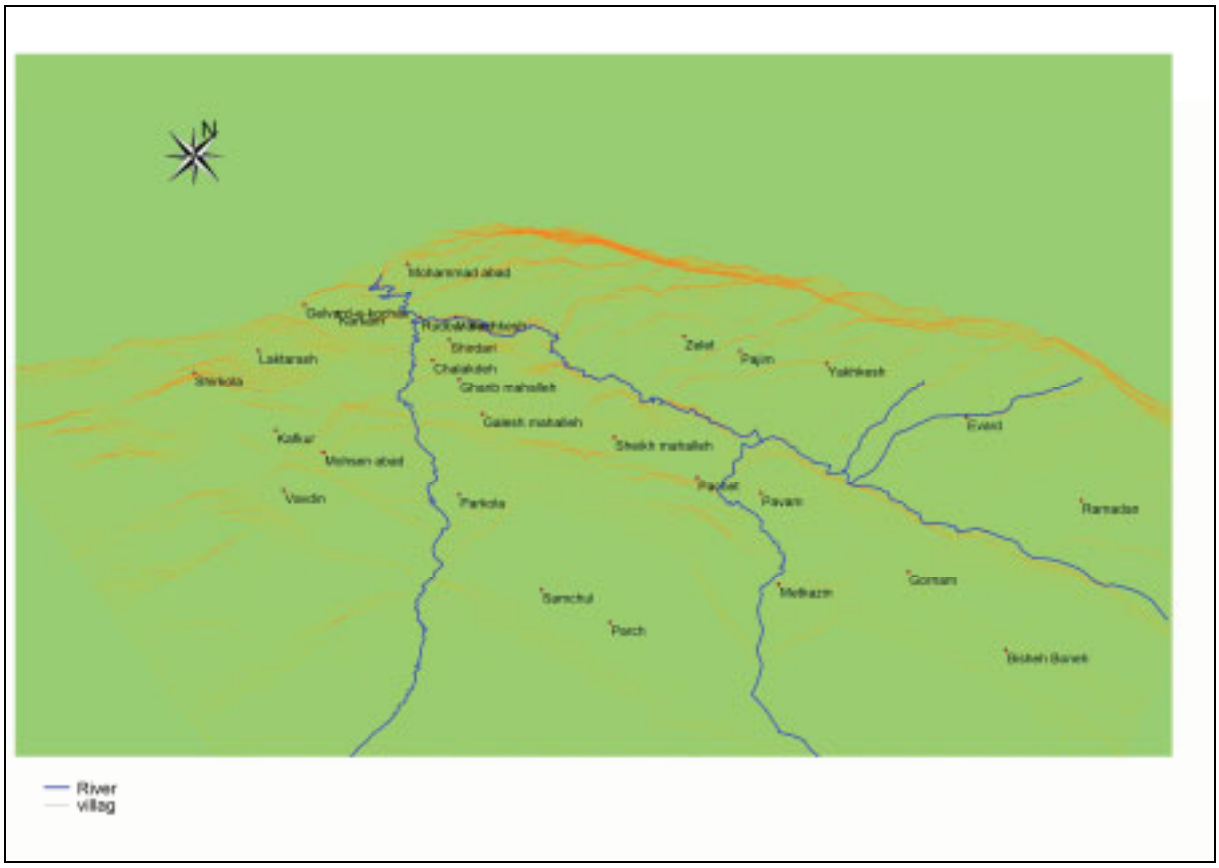
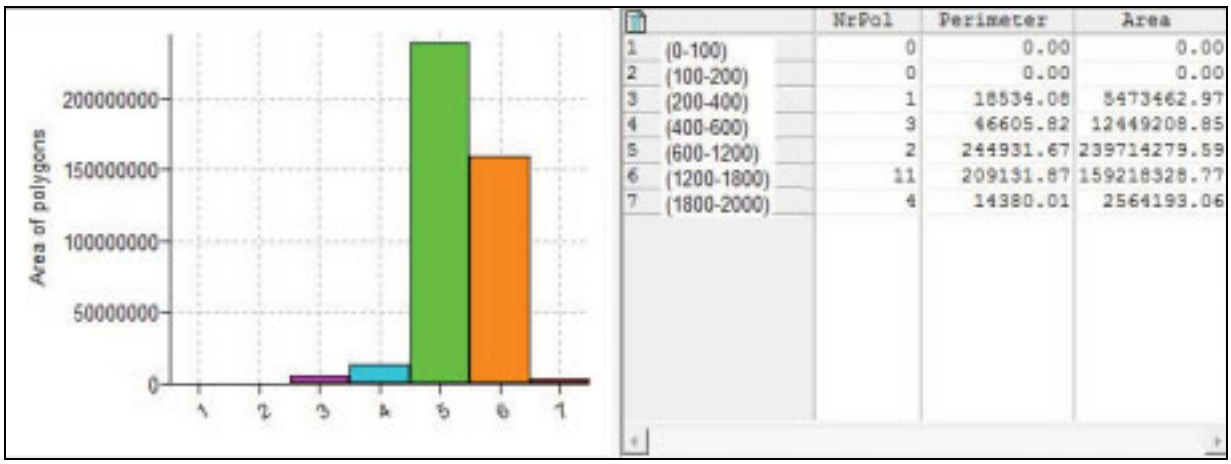


Figure 12: A 3D view of the study area from the south-eastern corner (gridline 150m) in ILWIS



		NrPol	Perimeter	Area
1	(0-100)	0	0.00	0.00
2	(100-200)	0	0.00	0.00
3	(200-400)	1	18534.08	5473462.97
4	(400-600)	3	46605.82	12449208.85
5	(600-1200)	2	244931.67	239714279.59
6	(1200-1800)	11	209131.87	159218328.77
7	(1800-2000)	4	14380.01	2564193.06

Histogram 1: Area estimation (m²) for the altitude classes

and Rusco-Fagetum in higher altitude between 700 up to 1800 m, Quercetum macranthera and Carpinetum orientale between 1800 up to 2200 m, and high grasslands for 2200 up to 2800 m and more (Mohajer 2005)

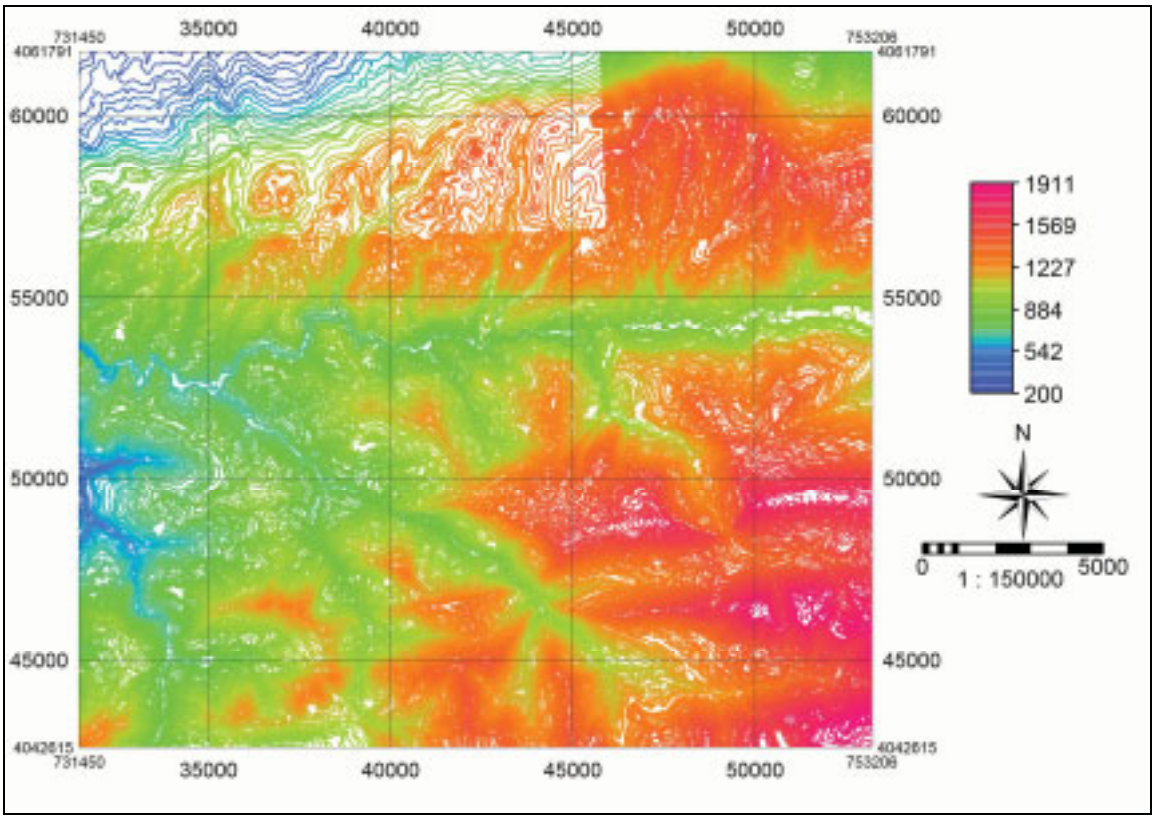


Figure 13: Outline of the topographic maps of the study area 1:25000, rescaled (Nouri, 2005)

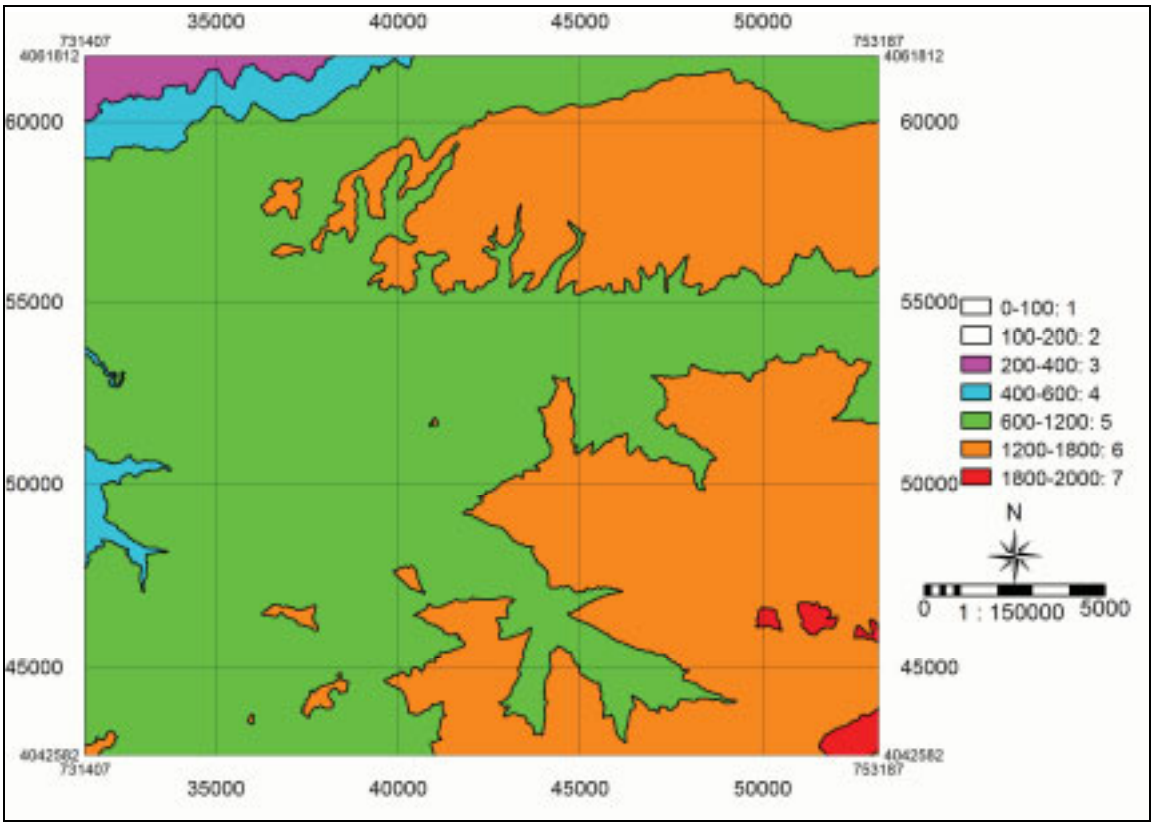


Figure 14: classified altitude map 1:25000, rescaled (Nouri, 2005)

Figure 15 shows the *Digital Elevation Model* (DEM) of the area on the scale of 1:25000, with a 15 square meter ground resolution (pixel size).

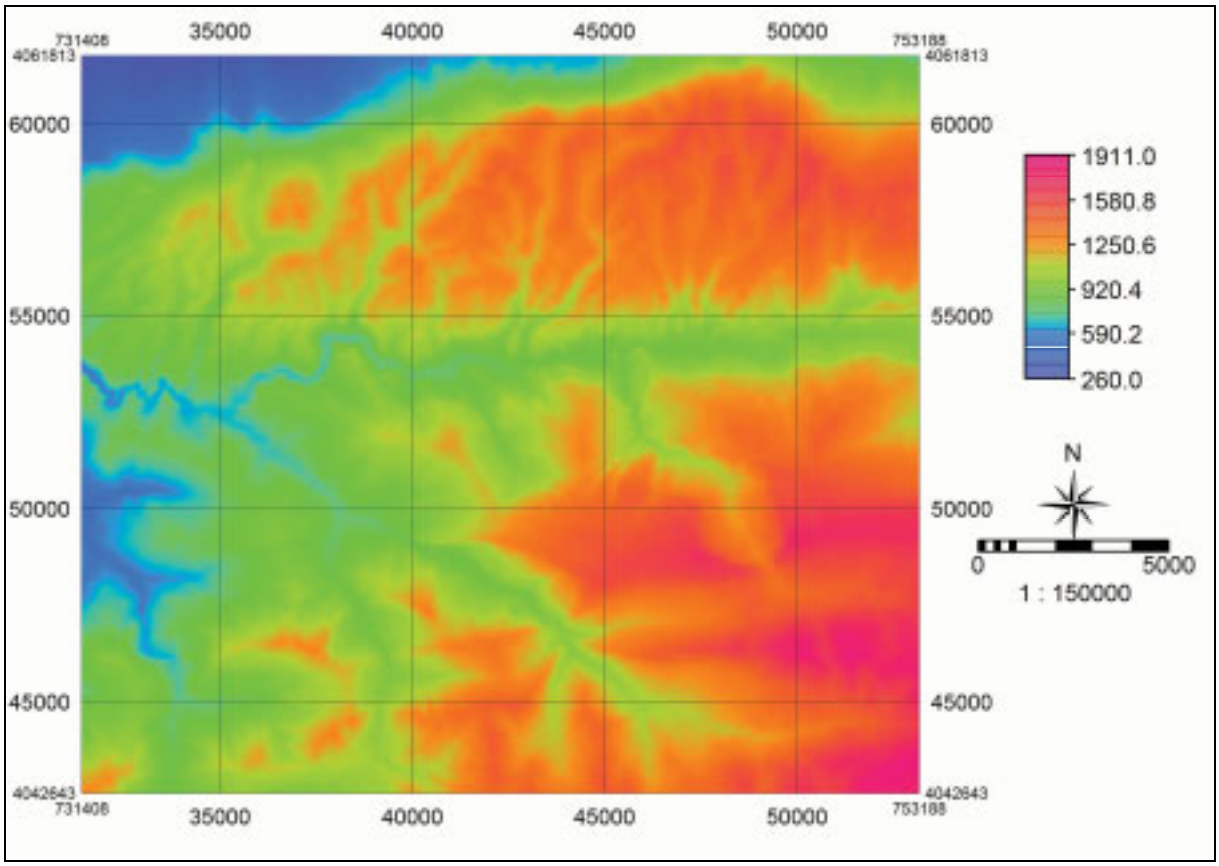


Figure 15: DEM of the study area 1:25000, rescaled (Nouri, 2005)

This raster map was produced in ILWIS 3.4 environment for the preparation of other needed data, especially the slope degree and the geographical aspect maps and for the analysis of the landform.

Figure 16 shows the slope degree map of the study area in 8 classes, which represent suitability for the main types of land uses in Iran[14], following the classification system of Makhdoum (1988-2002). This map was also prepared in the ILWIS 3.4 environment.

[14] it includes 7 capability classes for forestry and afforestation, one class for ecological protection/conservation, 2 classes for ecotourism (with & without facilities), 2 classes for urban, industrial, rural, military and infrastructures development, 1 class for aquaculture, 7 classes for agricultural activities (including: irrigated farming, animal husbandry, agricultural industries, poultry production, apiculture, silkworm culture, horticulture and rain-fed farming) and grassland management (cattle/sheep/goat raising) and 6 classes for watershed management activities (including 4 classes for flood and erosion control and 2 classes for sedimentation control measurements)

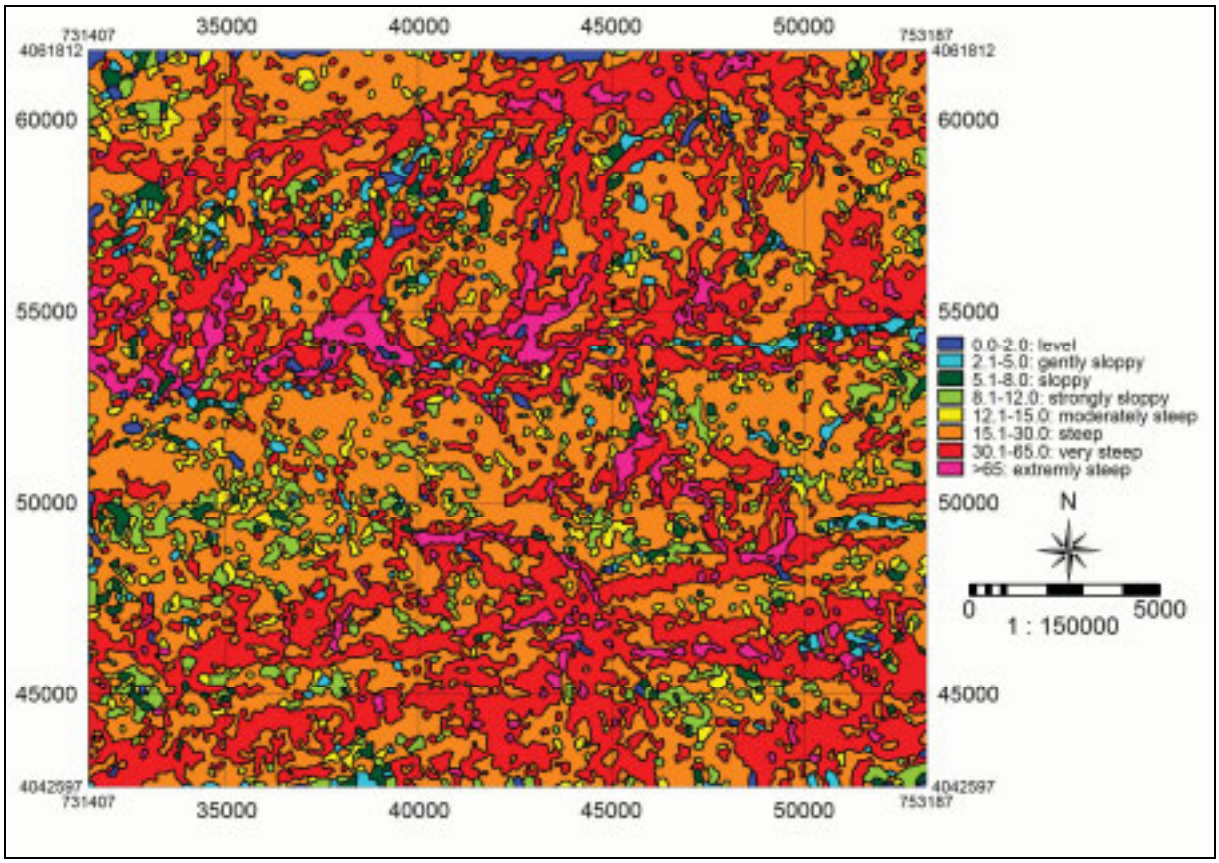
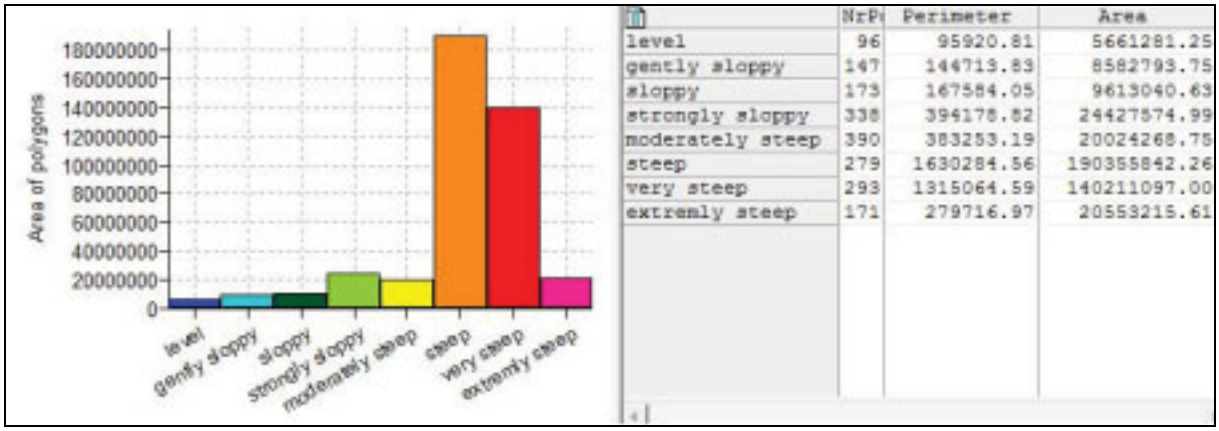


Figure 16: Slope degree map 1:25000, rescaled (Nouri, 2005)

Based on the map, the main part of the study area (79%) is steep or very steep and not suitable for cultivation (see Histogram 2).



	NrP	Perimeter	Area
level	96	95920.81	5661281.25
gently sloppy	147	144713.83	8582793.75
sloppy	173	167584.05	9613040.63
strongly sloppy	338	394178.82	24427574.99
moderately steep	390	383253.19	20024268.75
steep	279	1630284.56	190355842.26
very steep	293	1315064.59	140211097.00
extremly steep	171	279716.97	20553215.61

Histogram 2: Area estimation for slope degree classes (m²)

Figure 17 shows the main slope directions in the study area. This map was again produced in the ILWIS 3.4 environment from the DEM. Land with 10% or less slope percentage is considered as plain or flat areas. Generally, topsoils in Northern and Western slopes have more water supply and better profile evolution than Southern and Eastern ones, and thus provide

better conditions for the development of the natural vegetation covers or farmlands. The area estimation shows that around 34% of the area is located on the Northern, 27% on the Western, 23% on the Southern and 15% on the Eastern slopes, while flat areas are less than 1% (see Histogram 3).

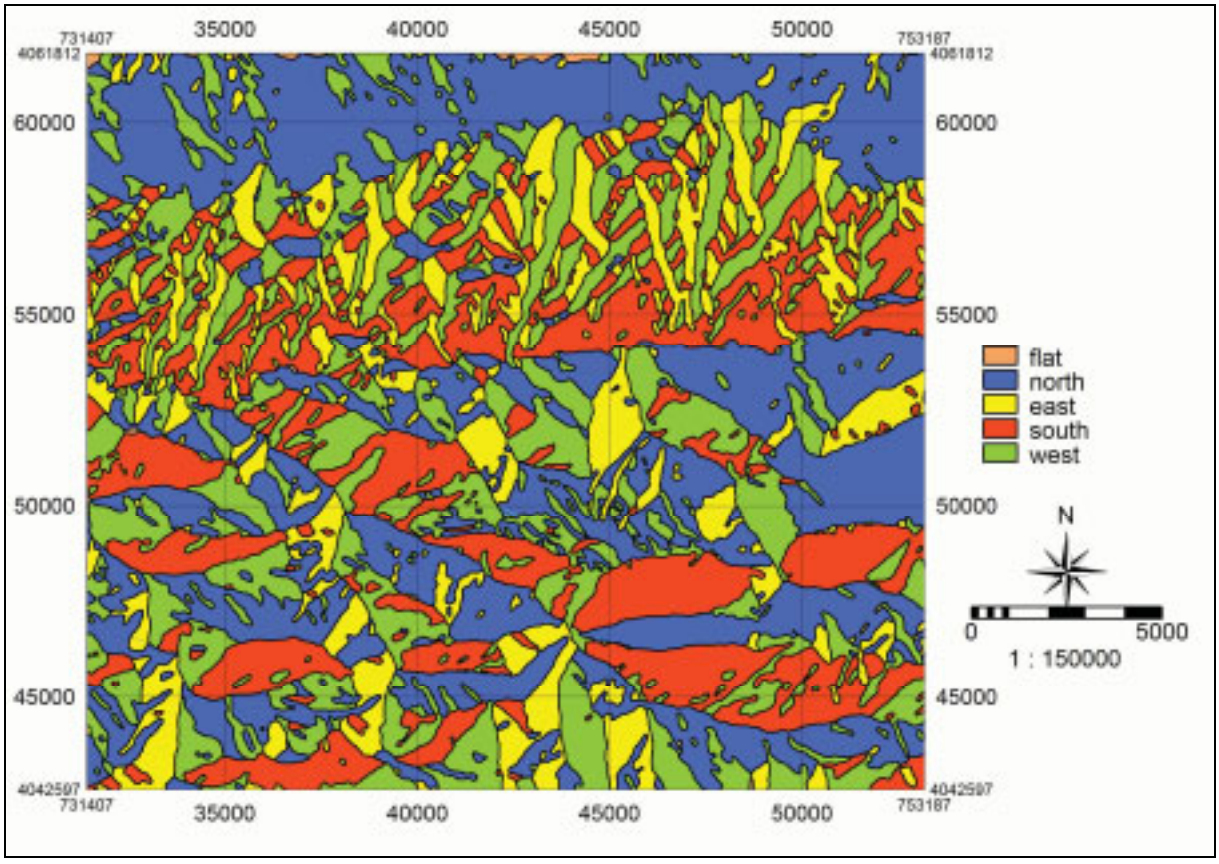
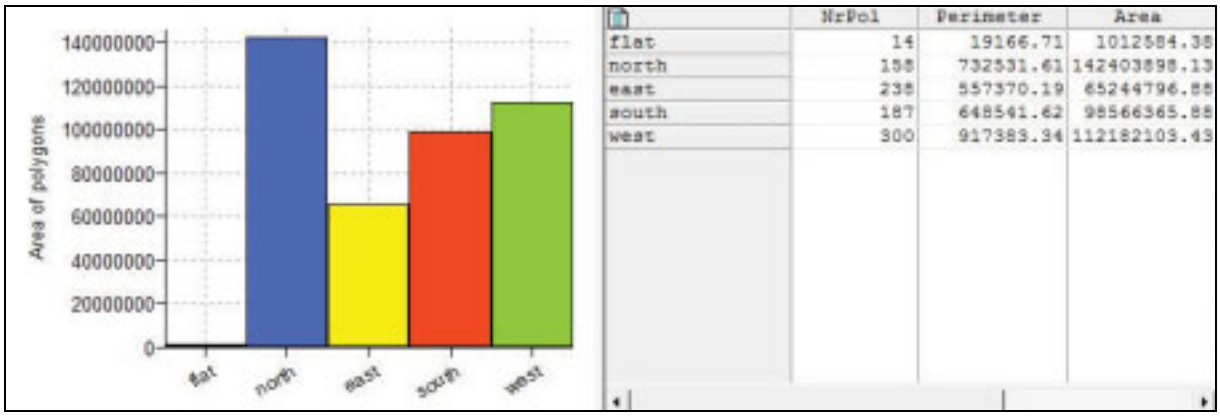


Figure 17: The main slope directions map 1:25000, rescaled (Nouri, 2005)



	NrPol	Perimeter	Area
flat	14	19166.71	1012584.38
north	158	732531.61	142403898.13
east	238	557370.19	65244796.88
south	187	648541.62	98566365.88
west	300	917383.34	112182103.43

Histogram 3: Area estimation for the main slope directions (m2)

4.1.2 Climate

Climatically, the project site is part of the Alborz Mountain zone. Winter stretches from November to March, with an average of 120 cold days per year. The dry season starts form April up to the end of July. The annual average temperature in the area is 12.2 °C, with a minimum of –4.5 °C in February and a maximum of 27.6 °C in August. The average rainfall is 610mm per annum, with a maximum of 87mm in December and a minimum of 5.3mm in August (MOAC 2001). In Iran, Amberge method is normally used in order to determine the climate class of the study area, based on the following equation (Khalili 1990):

$$Q_2 = (2000^* P) / (M^2 – m^2)$$

in which: P is the average annual precipitation in millimeter, M is the average temperature of the warmest month in Kelvin, and m is the average temperature of the coldest month in Kelvin.

$$Q_2 = (2000*610) / ((273.2 + 27.6)^2 - (273.2 - 4.5)^2) = 66.74$$

The Q_2 and m (in centigrade) are used in the Amberge climagram to determine the climate type. Based on the calculated data, the climate type of the study area is humid-cold. However, due to a decreasing precipitation gradient from the North-Western to the South-Eastern corners of the study area, the climate - especially from the central to the Southern and Eastern directions – changes to the semi-humid-cold and semi-arid-cold types.

In the De Martin climate classification method, an annual drought index (I_A) is calculated based on the following equation:

$$I_A = P / (t + 10)$$

In which P is the average annual precipitation in mm and t is the average annual temperature in centigrade.

For the study area, I_A is 27.5 which, according to the De Marten climagram, indicates a semi-humid climate. However, it changes to the Mediterranean type from center to the east and south corners. The existence of tree species, e.g. *Carpinus schuschuaensis Howinkl, Crataegus sp., Mespilus germanica and Pyrus boisseriana* in eastern and southern slopes show the effects of the Mediterranean climate, which are gradually substituted by *Quercus sp.*, *Carpinus betulus* and beech (*Fagus orientalis*) on northern slopes or higher altitudes with higher annual precipitation.

Figure 18 and Figure 19 show the temperature and precipitation zone maps of the area according to the annual averages. Figure 20 is an estimation of the climatic zone, generated by the MOAC- Mazandaran in a raster format., based on the available climatologic data, change of the temperature and precipitation gradients by altitude, DEM and the national climatologic map of Iran (scale: 1: 1000000)

An estimation of the entire area of each zone is presented in the Histogram 4. A broad central stripe of the area (55.2%), stretching from the north to the south, is influenced by the cold semi-moist climate whereas the temperate-moist climate (30%) affects the following western parts. The temperate-Mediterranean climate covers only 13% of the eastern area, which is located on the transition zone between the humid Caspian region and the semi-arid Southern slopes of the Alborz Mountains. Another 2 % of the study area in the very north-western part is affected by the warm-moist and temperate-semi moist climate.

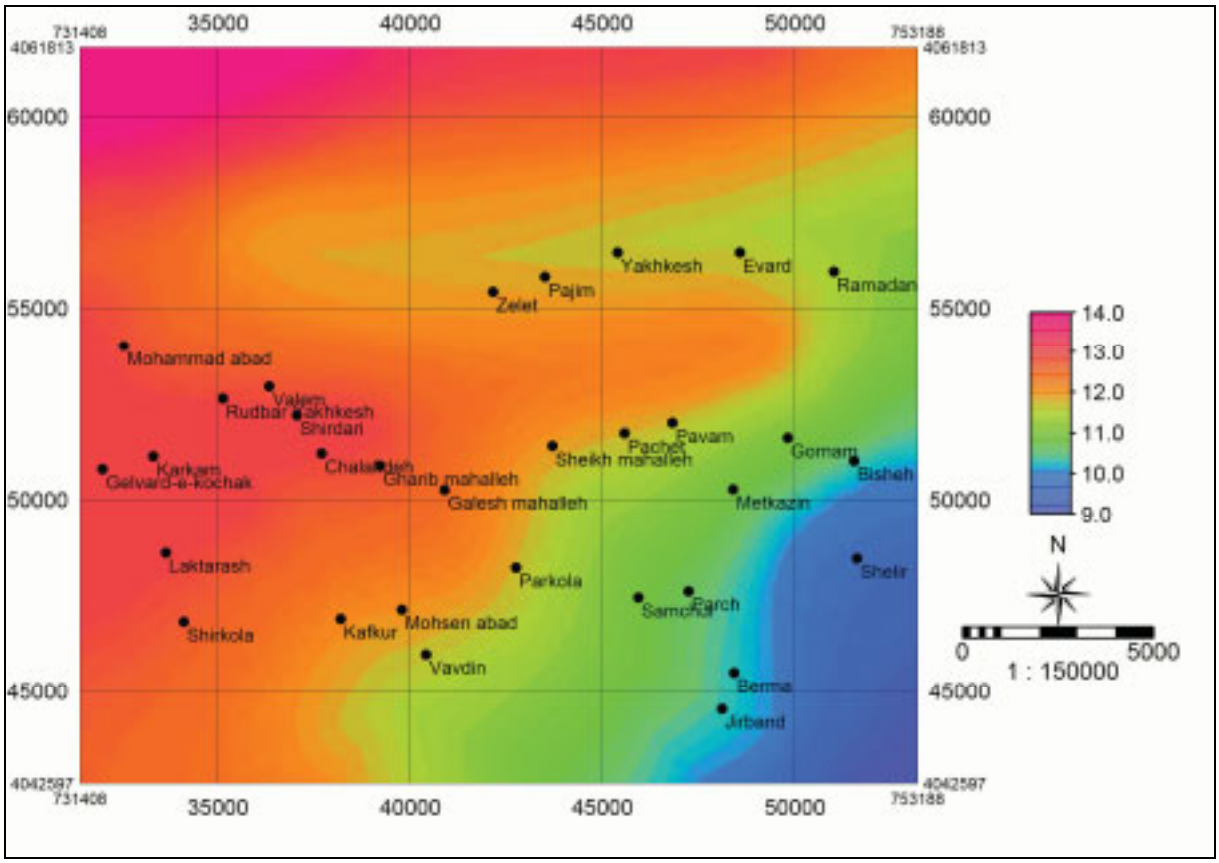


Figure 18: Annual mean temperature (°C), rescaled (from MOAC, Mazandaran 2004)

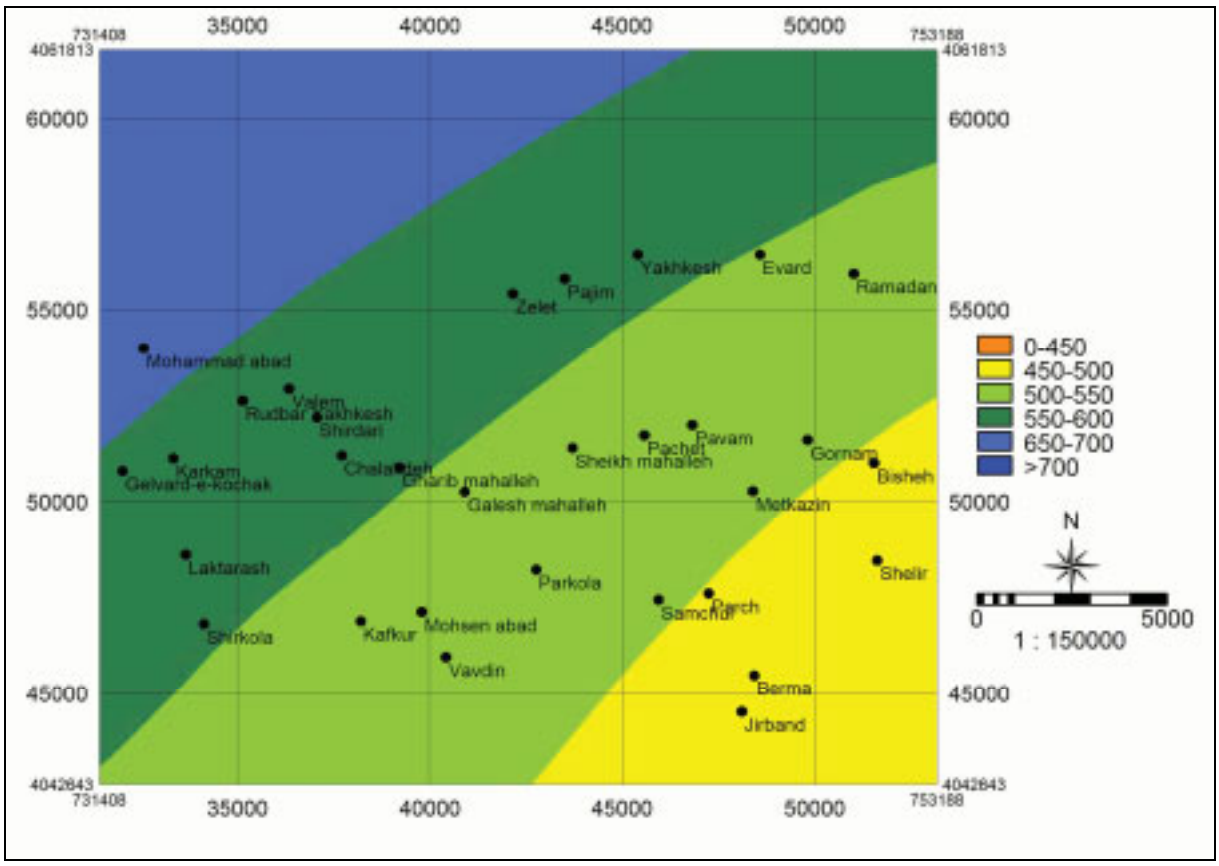


Figure 19: Annual precipitation (mm/year), (rescaled from MOAC, Mazandaran 2004)

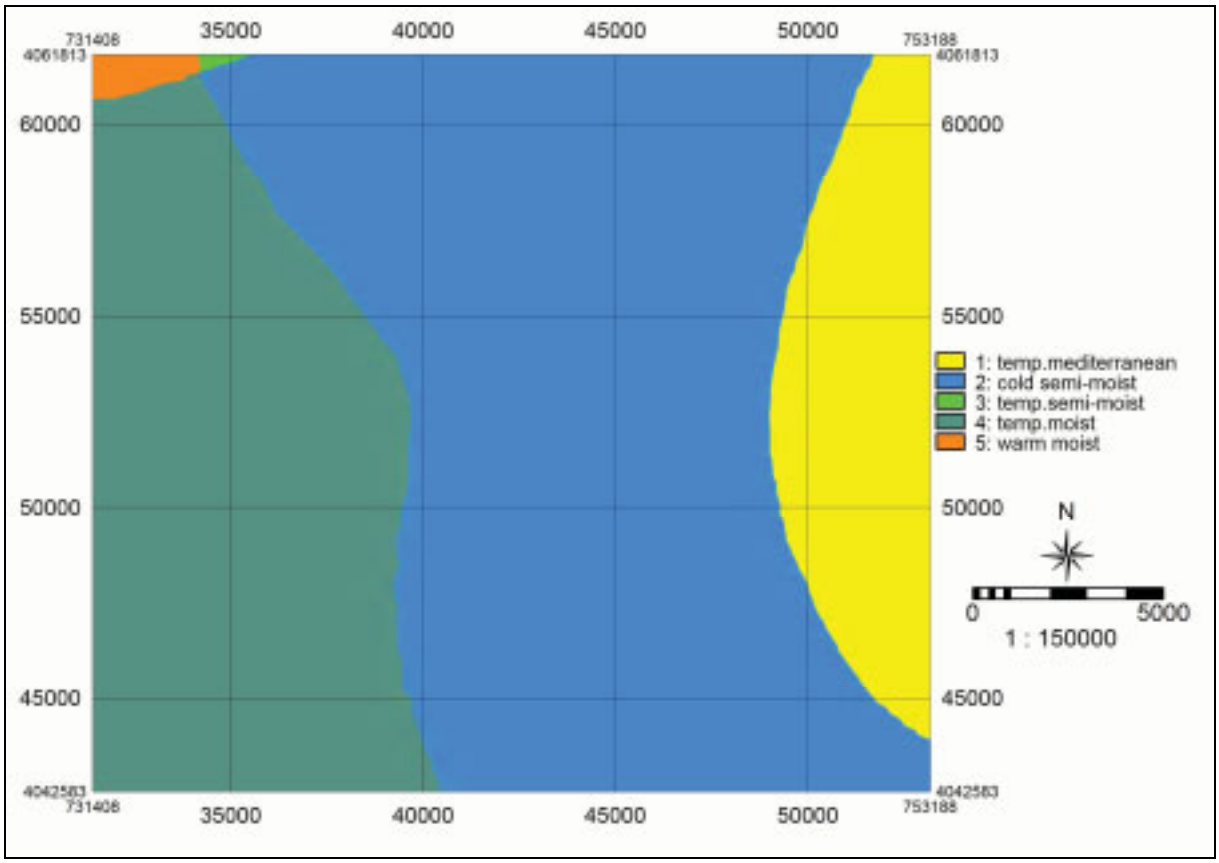
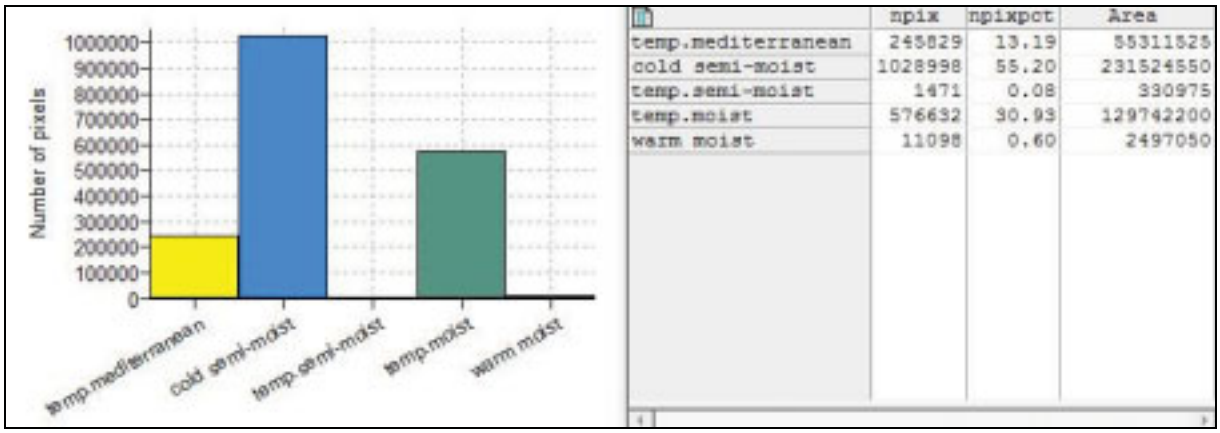


Figure 20: The climatic zones in the Study area (rescaled from: MOAC, Mazandaran 2004)



	npix	npixpct	Area
temp.mediterranean	245829	13.19	55311525
cold semi-moist	1028998	55.20	231524550
temp.semi-moist	1471	0.08	330975
temp.moist	576632	30.93	129742200
warm moist	11098	0.60	2497050

Histogram 4: Area estimation for different climatic zone in the study area

4.1.3 Geology

The Alborz mountain ranges form the folded fringe of the vast Iranian plateau and have been made by two major mountain formations. The first movements leading to the formation of Alborz date back to the Paleocene epoch. In early Cenozoic, drying up of the northern part resulted in the formation of Alborz mountain ranges. The second phase of mountain formation occurred in early or mid Oligocene, and resulted in the elevation and subsequent erosion of the central Alborz belt and eventually the thick deposition of Moles. The Alborz Mountains cannot be considered as the upshot of an individual mountain formation movement. Their formation rather must be attributed to considerably wider movements including the entire Iran and Caucasian mountains, which are surrounded, by Saudi Arabian plate in the south and the Russian plate in the north (RIFR, 2006). Figure 21 shows the geological map of the Yakhkesh area.

This geological map was prepared by *MOAC- Mazandaran* using the geologic map of Iran (scale: 1:1000000 and 1:250000 by Iranian Geology Organization) on a 1:100000 scale and then resampling it to 1:25000 in ILWIS and Arcview. Based on this map, the major part of the area comprises by two major rock units, e.g. the massive limestone along the southern Mehraban-rood river and dolomite limestone and limestone (Lar formation) in the northern areas. The latter is highly resistant against erosion and weathering producing Karsts in the study area. The Karsts regions contain aquifers that are capable of providing large supplies of water. Springs, as the main sources of groundwater and caves result from the existence of Karsts in the study area.

The main rock units and geologic formations of the study area are as follows:

1. Quaternary sediments (Qal), which are mainly found on the Mehraban-rood River's bed in the eastern part of the study area. Based on the map, the area of this unit is around 212 ha (0.5% of the total area).
2. Upper Miocene unit (Mmsl), including Marl, limey Sandstone and sandy Limestone with Conglomerate. This rock unit has a strip shape, which extends from the East to the center, but covers also another area in the west. Total unit area is around 1923 ha (4.6%).
3. Lower Miocene unit (Mc), including Conglomerate and red Sandstone that covers around 875 ha (2.1%) of the area in the eastern and central parts.

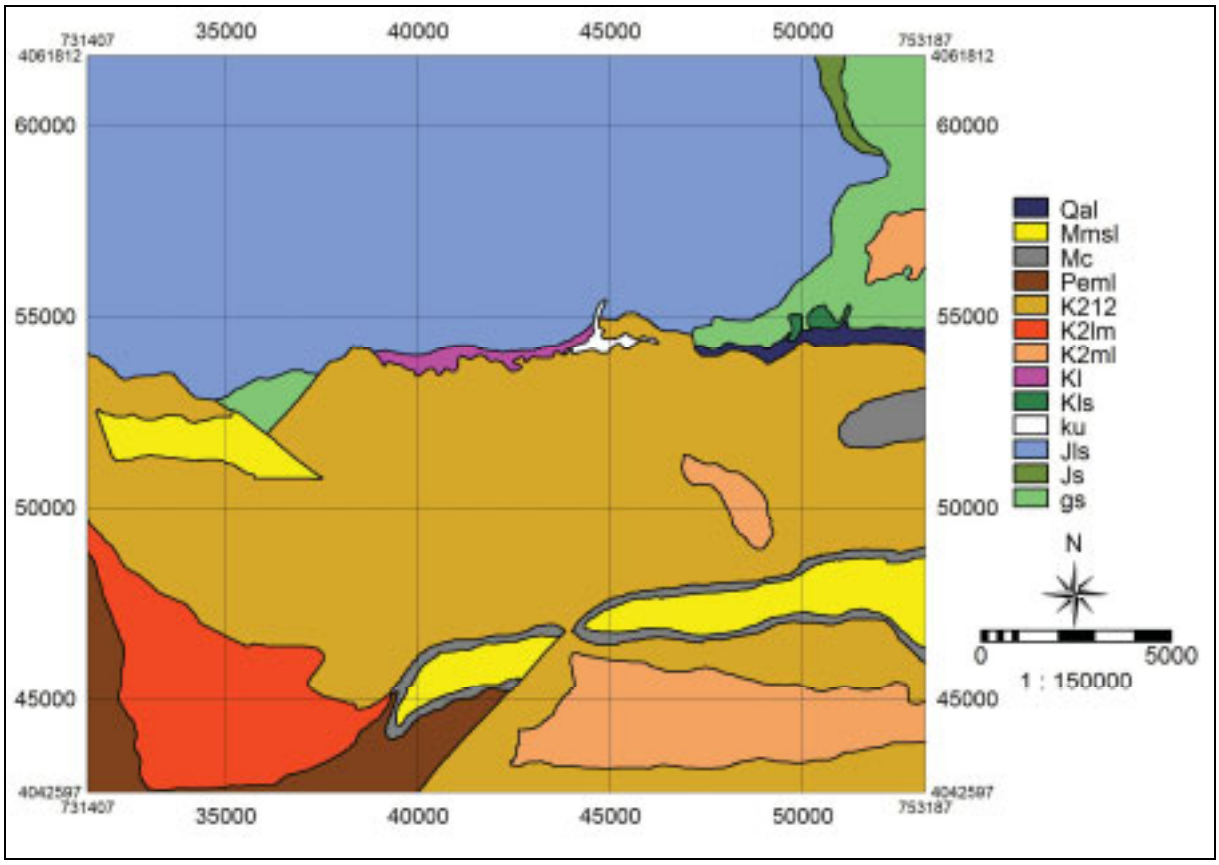
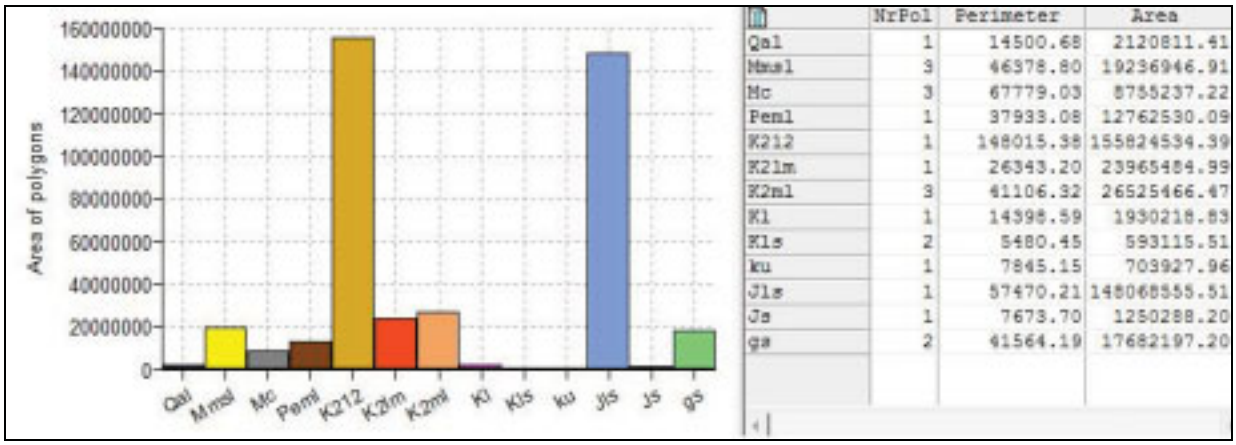


Figure 21: Geological formations map, includes Quaternary sediments (Qal), upper Miocene unit (Mmsl), lower Miocene unit (Mc), Paleocene unit (Peml), Upper Cretaceous units with Gorgan Schists (K_{212}, K_{2lm}, K_{2ml}, K_l, K_{ls}, K_u, K_{2ml}), Lar formation (J_{ls}) of the Jurassic, Shemshak formation (J_s) of the upper Triassic and (g_s) unit, formations with no recognized age (Source: MOAC, Mazandaran 2004)



	NrPol	Perimeter	Area
Qal	1	14500.68	2120811.41
Mmsl	3	46378.80	19236946.91
Mc	3	67779.03	8755237.22
Peml	1	37933.08	12762530.09
K212	1	148015.38	155824534.39
K2lm	1	26343.20	23965484.99
K2ml	3	41106.32	26525466.47
Kl	1	14398.59	1930218.83
Kls	2	5480.45	593115.51
ku	1	7845.15	703927.96
Jls	1	57470.21	148068555.51
Js	1	7673.70	1250288.20
gs	2	41564.19	17682197.20

Histogram 5: Area estimation for the main geological formations

4. Paleocene unit (Peml), including Marl, Limestone and silted Marl that covers around 1276 ha (3%) of the south-western corner of the study area.

5. Upper Cretaceous unit (K_{212}), which mainly includes deep layers of massive Limestone. The southern areas of Mehraban-rood river is mainly covered by this rock unit. The total unit area is around 15582 ha, 37.1 % of the study area.
6. Upper Cretaceous unit (K_{2lm}), including marled Limestone, Marl and silted Marl that mainly covers the south-western corner of the study area with an area around 1923 ha (4.6%).
7. Upper Cretaceous unit (K_{2ml}), including Marled, silted Marl and marled Limestone that is mainly located on the south-eastern corner with an area about 2652 ha (6.3%)
8. Upper Cretaceous units, including (K_l): mainly Limestone that rarely contains Marl layers (193 ha, less than 1%), (K_{ls}) Gorgan Schists and upper Cretaceous sediments including Marl, silted Marl and marled Limestone (59 ha, less than 1%), (K_u) upper Cretaceous Limestone and Gorgan Schists (70 ha, Less than 1%)
9. Upper Cretaceous unit (K_{2ml}), including Marled, silted Marl and marled Limestone that is mainly located on the south-eastern corner with an area about 2652 ha (6.3%)
10. Upper Cretaceous units, including (K_l): mainly Limestone that rarely contains Marl layers (193 ha, less than 1%), (K_{ls}) Gorgan Schists and upper Cretaceous sediments including Marl, silted Marl and marled Limestone (59 ha, less than 1%), (K_u) upper Cretaceous Limestone and Gorgan Schists (70 ha, Less than 1%)
11. Jurassic; Lar formation (J_{ls}) which includes dolomite Limestone and Limestone and covers the most part of the Northern area of Mehraban-rood river. Total unit area is around 14807 ha (35.3%).
12. Upper Triassic; Shemshak formation (J_s) which includes Shale, Sandstone, Siltstone, Clay stone, Marl with Charcoal layers (rare in this area), quartzite Conglomerate and covers a little part of the North-western corner. Total unit area is around 125 ha (less than 1%)
13. (g_s) unit (age is not recognized), including Gorgan Schist, Quartzite, Dolerite (Dia-base) and alkali volcanic rocks which covers the major part of the north-western corner. Total area is around 1768 ha (4.2%) (see Histogram 5)

4.1.4 Soil

Due to its topographical, climatic and particularly its lithologic diversity, Iran displays a rich mosaic of soils. Zohary (1963) and Dewan and Famouri (1964) delivered a geo-botanical classification of the soils, which is the main source of information for related studies on the larger scales across the country. This classification is mainly a geobotanical review that considers all kinds of substrates and their relation to different vegetation covers. It considers both the climatic as well as the geobotanic conditions of the soil series.

Climatically, the soils of Iran can be classed into humid, semi-humid and arid ones. From the geobotanical point of view, the soils can be subdivided into regional and interregional ones. The former comprises all soil series, which are definitely confined to climatic and plant geographical regions, such as forest soils and steppe soils. Interregional soil units are those that may occur in various plant geographical regions, although slightly or markedly varying in their vegetation cover each time. Such soils are not necessarily related to the climatic vegetation complexes of the region and, examples are sandy soils, swamps and marshes. As long as they preserve their primary pedological nature, these soils will sharply differ in their vegetation from other soils of the region, while showing more vegetation affinity to the similar soils in alien regions (Badripour, 2006). Based on RIFR (2006) and according to the regional soil groups, the most important soil types in the Hyrcanian (Caspian) region are the following:

- **Brown soils** are the most abundant soils in the Northern forests and comprise approximately 90% of the Hyrcanian region. Generally, they show a well developed profile with a humiferous A-horizon, moderately acid to alkaline. These semi-deep soils occur on mild slopes and include calcareous, forest acidic, podzolic and non-podzolic soils. The forest type is represented in nearly all regions, and under *Querco-Carpinetum* and especially *Fagetum* communities. The calcareous type is often found in the eastern parts and under *Querco-Carpinetum* communities while the acidic type, as the most fertile one, is found in the western parts and under *Fagetum* communities. The typical brown forest soil is less extensive than its more ruined or skeletal derivative (lithosol faces), or its alluvial variety deposited in the intermountain valleys. It occurs as fine textured soil being largely under cultivation.
- **Rendzina soils** are independent of climatic factors and are generally found on steep slopes and hard limestone parent rocks where, *Parrotietum, Parrotio-Carpinetum* and

Tilio-Buxetum often come to existence. However, true rendzinas developing from soft marl limestone are confined to humid or semi humid areas. They are generally characterized by their dark-coloured usually calcareous surface horizon, which sharply contrasts with the marly or chalky white parent rock. In Iran, these soils are not uncommon in the forest areas of the mountains but are often intermixed with other types. They occur in some varieties, according to topography and conservation of profile. Forms with mature profiles have only persisted under forest vegetation. Apart from the black rendzinas there are also light-coloured and grayish-brown ones.

- **Alluvial soils** account for a wide area of the region and even the entire country. They are very old soils dating back to the Quaternary Period and cover plains, valleys and most riverbeds. The material is largely transported from the mountains and then deposited, and thereby physically changed. There is no mature profile in these soils because of the steady rejuvenation of the upper horizons. Alluvial soils in this sense, do not include hydromorphic deposits, they are ecologically zonal soils, because they are apt to harbour plant communities of the same regional vegetation complex as the adjacent mountains that supply the soil material. No natural vegetation has been left in most of these alluvial plains. One should also include the terraces of the mountain slopes which have been under cultivation since immemorial times and are inhabited by a particular weed flora. The alluvial soils in the above sense are not typological units in themselves. They are a derived form of the oropedic group just as the lithosols which form another derivative.

- **Colluvial soils** often occur in damp valleys or on low slopes covering calcareous and acidic parent rocks. They are deep and uniform soils with high humus content that form suitable sites for maple, lime tree, alder and ash.

- **Lithosols are t**he most primitive unweathered soils, which generally occur on the Alborz southern slopes and highlands or on lime and marl structures of some dry valleys.

Information about the main soil groups is only available for a small part of the Yakhkesh area, and mainly produced by *FWRO-Mazandaran,* as a part of the feasibility study of the *Tirtash-Galugah forest management plan* in the northern and north-eastern part (Amuzad,

2003). In this report the following main soil types are recognized in the northern areas of the Mehraban-rood river:

- Ranker (without a mature profile)
- Brown forest soils (both calcareous and acidic types)
- Brown soils (eroded, with Pseudogenic or Argyllic horizon)

Picture 2: Left, a vertical profile of the conglomerate substrate with a thin layer of Leptosol (near Pachat). Right, gully erosion in steep slopes of "Mehraban rood" river (Nouri, 2005-7)

Due to the lack of detailed mapping of the major soil types, *MOAC-Mazandaran* (2004) produced 2 different raster maps for the UNDP-GEF project using the available data, especially geology and slope degree. These maps show the soil texture and the soil depths in four classes, which cover the whole study area. Figure 22 shows the soil textures in 4 different classes. These includes: "Heavy", "Semi-Heavy", "Moderate to Semi-Heavy" and "Moderate" which represents the "Clay", "Clay-Loamy", "Loamy to Clay-Loamy" and "Loamy" textures, respectively. The area estimation for each of these classes shows that more than 76% of the area is covered by soils with heavy (39.5 %) and semi-heavy (37%) textures, while only around 14% have moderate to semi-moderate textures, that seem to be suitable for agricultural activities (see Histogram 6).

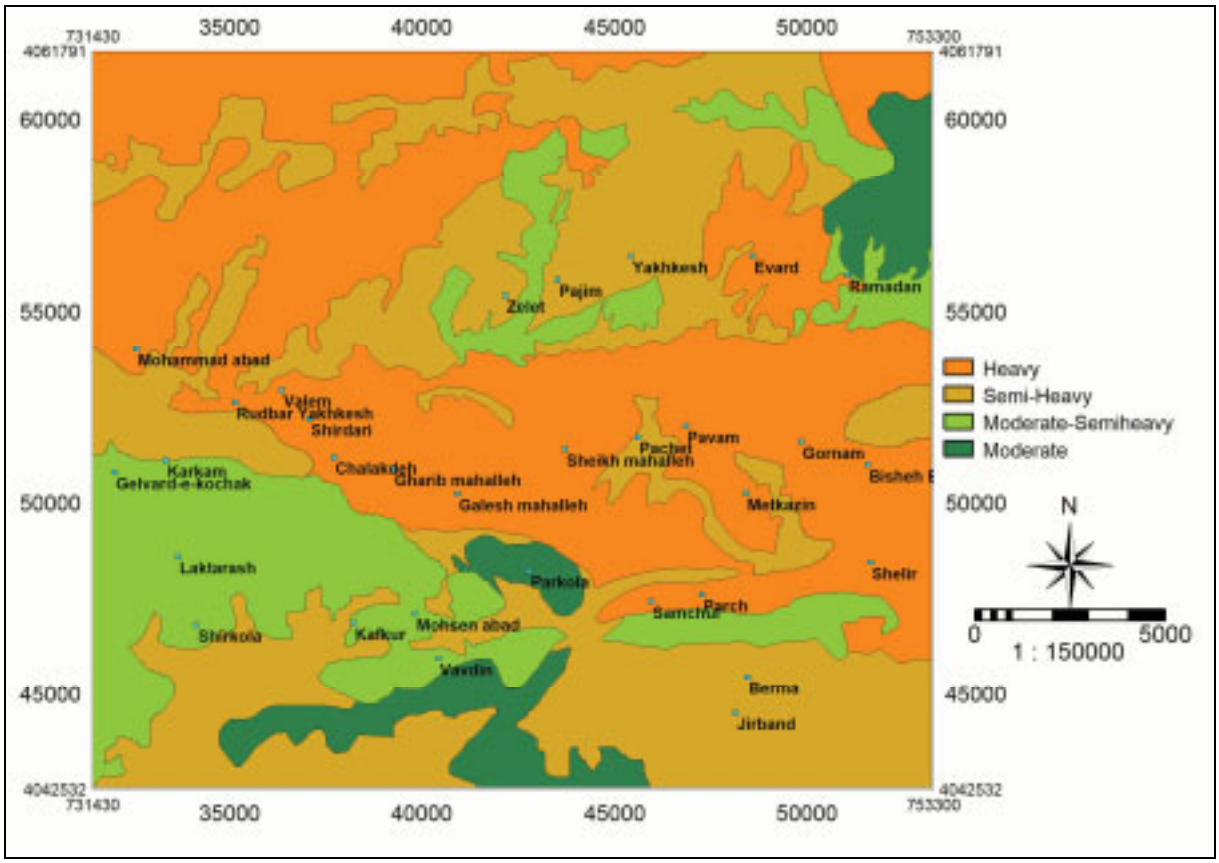
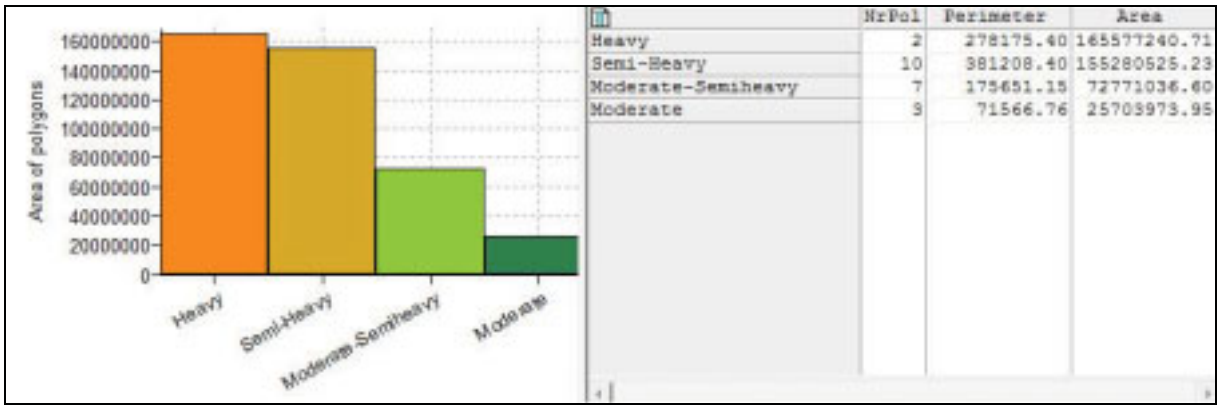


Figure 22: Soil texture map, rescaled to 1:25000 (from: MOAC, Mazandaran 2004)



	NrPol	Perimeter	Area
Heavy	2	278175.40	165577240.71
Semi-Heavy	10	381208.40	155280525.23
Moderate-Semiheavy	7	175651.15	72771036.60
Moderate	3	71566.76	25703973.95

Histogram 6: Area estimation for soil texture classes in the Yakhkesh area

Figure 23 shows the soil depth classes as: shallow (up to 50 cm), semi-deep (50 to 80 cm), semi-deep to deep (80 to 100 cm) and deep (100 cm or more). The area estimation for each class shows that around 78.4% of the area is covered by the deep (54.8%) and semi-deep to deep (19.6%) soils and only 14.2% is covered by shallow soil types (see Histogram 7).

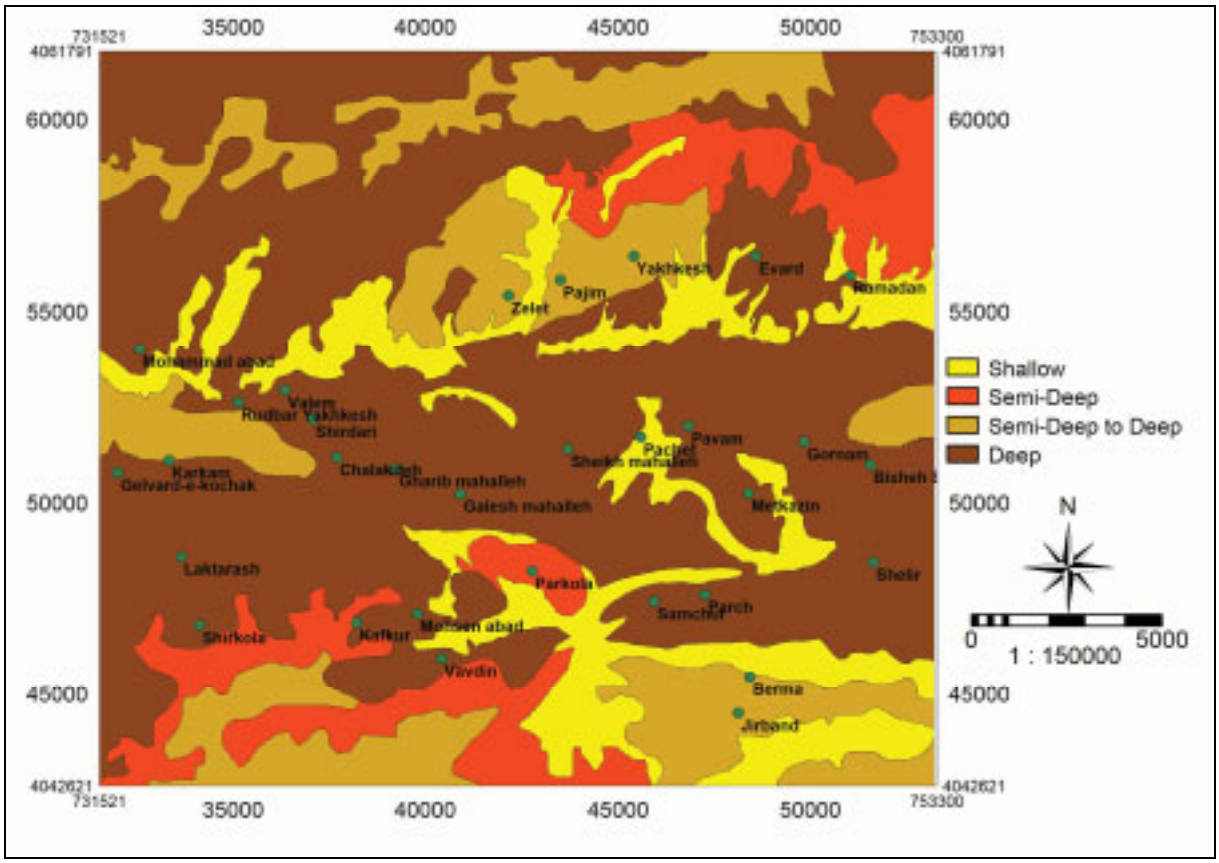
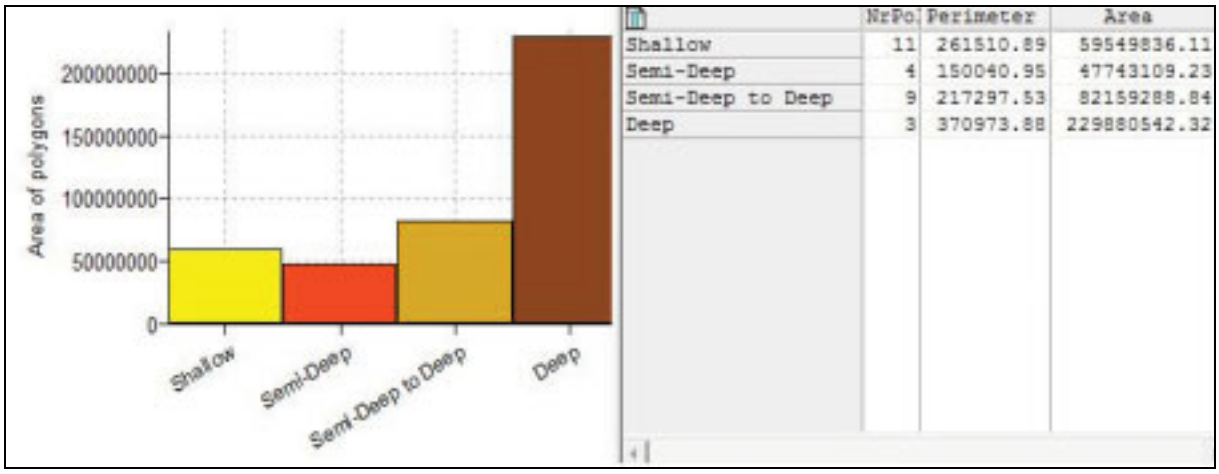


Figure 23: Soil depth map, rescaled to 1:25000 (Source: MOAC, Mazandaran 2004)



	NrPo.	Perimeter	Area
Shallow	11	261510.89	59549836.11
Semi-Deep	4	150040.95	47743109.23
Semi-Deep to Deep	9	217297.53	82159288.84
Deep	3	370973.88	229880542.32

Histogram 7: Area estimation for soil depth classes in the study area

Regardless of soil depth or texture, the brown soils in the Yakhkesh area and other mountain forest areas across Alborz, are rather not ecologically suitable for cultivation. This is mainly due to the lack of nutrients, leaching and high potentials to erosion in the humid climate. A rough estimation by local MOAC-Mazandaran shows that the erosion rate reaches more than 14 tons/ha in the farmlands, that origin from recent forest conversion (MOAC 2001).

4.1.5 Surface and underground waters

The area is watered by the Neka River, a permanent river of 180km length that empties into the Caspian Sea, 22km to the north-west of Neka city. The river has an average slope of 1.8% and a total discharge of 150 million cubic meters per year, with peak flood in March-May and minimum levels in June, August and September (Ministry of Agricultural crusade, MOA, 2000). Two smaller tributaries, the Shirdari and Metkazin rivers, flow through parts of the project area (Figure 24).

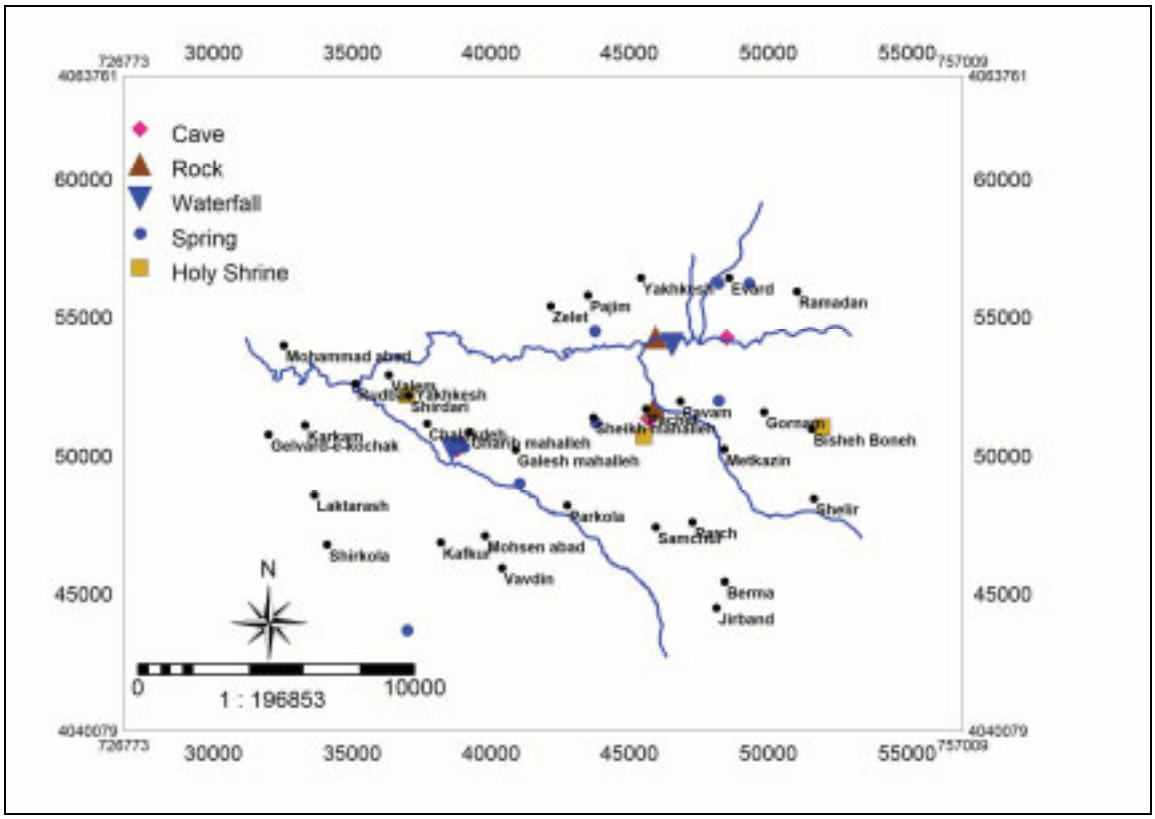


Figure 24: Surface and underground water resources

Significant deforestation has occurred in the upper reaches of the Neka watershed, which resulted in severe floods in July 1999 (Nouri, 2000).

Karst formations are the main sources of groundwater in the Yakhkesh area. Approximately 250 springs rise in the project area, mainly located on the mountain foots. The use of both, surface and underground water supplies are difficult due to the altitude difference between the villages and the rivers or springs. However, 12 springs play a vital role in meeting the demand for agricultural and drinking water. The average discharge of these springs is estimated to vary between 0.5 up to more than 135 liters per second (MOAC, 2001). The “Senbee” near Yakhkesh and the “Asbe-o” near Zelet village have the largest discharge (135 and 35 litter / s,

Picture 3: The Mehraban- rood River (Nouri, 2007)

Picture 4: The Senbee waterfall (Nouri, 2007)

respectively) in comparison to others. The Senbee spring creates a beautiful waterfall, which is one of the main tourist attractions in the area, especially for eco-tourism (see Picture 4). So

far, there has been no investigation on the water pollution sources and levels of the Neka River. However, seasonal pollution with pesticides (especially Granola, Zinon or Hinozan) is possible originating from measures to protect rice fields against rice-worm or Blast. A rough estimation by MOAC expert shows that pesticide control is seasonally done for 50 to 70 percent of the 1000 ha rice fields in the upstream of the Neka River. Additionally, sewage is directly discharged to the river, due to the general lack of sewage collection systems in rural areas.

4.2 Biodiversity

4.2.1 Flora and Vegetation

❖ The Caspian Flora and Vegetation

The Caspian flora is undoubtedly the best characterized in Iran due to a climate, which remains humid throughout the year. As there is no real summer drought, the Caspian flora has comparatively few affinities with the Mediterranean flora (few species with evergreen foliage). It resembles much more that one of the southern Caucasus and the northeast coast of Turkey, and includes many species of the European temperate zone. It is essentially a forest flora, of which almost all the trees and bushes are deciduous (Sabeti 1976, Mohajer 2005, Badripour 2006). The indicator tree species of the Hyrcanian zone are as follows (Sabeti 1976, Mohajer 2005, Badripour 2006):

Acer cappadocicum	*Cupressus sempervirens*	*Pterocarya fraxinifolia*
Acer velutinum	*Diospyrus lotus*	*Quercus castaneifolia*
Albizia julibrissin	*Fagus orientalis*	*Sorbus torminalis*
Alnus subcordata	*Fraxinus excelsior*	*Taxus baccata*
Buxus hyrcana	*Gleditschia caspica*	*Tilia platyphyllus*
Carpinus betulus	*Parrotia persica*	*Ulmus glabra*
Cerasus avium	*Popolus caspica*	*Zelkova carpinifolia*

Among these, four species namely, *Buxus hyrcana, Parrotia persica, Popolus caspica* and *Gleditschia caspica* are endemic to the Hyrcanian zone.

❖ The Hyrcanian forest belts

The great differences in altitude permit the distinction of at least three belts of vegetation. The approximate limits of these belts appear to increase in altitude going from the West to the East, partly because of the decrease in temperatures (Badripour, 2006):

- **Lowest forest belt** (reaching approximately 800 to 1,000 meters): The fundamental tree is in principle *Quercus castanaefolia* whereas the understorey is frequently dominated by *Buxus sempervirens*. C*arpinus betulus, Zelkova crenata, Parrotia persica, Albizia sp., Gleditsia caspica, Diospyros lotus, Ficus carica, Tilia rubra*, and *Acer* spp., are generally the dominant trees. With the exception of a narrow coastal strip that supports mostly annuals, there is practically no pasture extending over a wider area. However, annual grasses (especially *Setaria* spp.) are much more abundant than the perennial grasses like *Brachypodium pinnatum, Dactylis glomerata, Andropogon ischaemum, Poa* spp. and on the driest slopes *Aristella bromoides, Festuca ovina, Stipa* sp., *Melica* sp., and *Phleum boehmeri*. Legumes are little abundant, but most noteworthy are the annual or perennial *Trifolium* and several perennial *Onobrychis species*.
- **Medium forest belt** (approximately 800 to 2,000 meters): This belt corresponds to the zone of maximum rainfall. The famous beech forests of *Fagus orientalis* occur in these moist and cool areas of the Caspian region, but *Carpinus betulus* is often the dominant tree which frequently associates with *Acer insigne*, *A. laetum, Tilia rubra, Ulmus glabra, Fraxinus excelsior, Taxus baccata, Sorbus* spp. and many bushy species. A few species of the lower belt (*Parrotia, Zelkowa, Diospyros*, etc.) do climb as high as 1,400 m and even higher in the east where the beech is absent and occasionally replaced by *Taxus baccata*. The driest areas are populated by *Quercus castanaefolia, Carpinus betulus, Carpinus orientalis* and several *Acer* species (up to five species in the higher regions of this forest belt). Forest felling favours the multiplication of the bushy species *Ilex, Prunus, Lonicera, Crataegus, Rhamnus, Mespilus, Rosa*, etc. The herbaceous vegetation is always poor when the forest canopy is dense but becomes very rich in those areas that are exposed to the sun. Perennials largely dominate annuals. Among the perennial grasses the following should be noted: *Festuca montana, Aristella bromoides, Agropyron panormitanum, Brachypodium sylvaticum, Dactylis glomerata, Phleum boehmeri*, *Melica* spp., *Bromus* sp., *Trisetum* sp., *Poa* spp. The following forage legumes mingle: *Trifolium pratense, T. repens, Lotus corniculatus*,

Coronilla spp., *Onobrychis* sp. and, in the highest areas the spiny *Astragalus*, an element of the Irano-Turanian flora, may occur.

- **Upper forest belt – or "sub-alpine belt"** (approximately 2,000 to 2,700 meters): This belt, which grows under both drier and colder conditions, is transitional with the steppe-like pastures of the higher regions. It is difficult to define its precise altitudinal limits because of the destruction of most of the woody flora which comprises various *Acer, Sorbus, Crataegus, Rhamnus, Prunus, Cotoneaster, Juniperus communnis, J. sabina, Lonicera caucasica, Viburnum lantana, Berberis integerrima*, etc. There is even one localized colony of *Betula verrucosa*. The herbaceous vegetation is very rich but varies greatly with the degree of soil humidity and exposure. The dominant perennial grasses are *Bromus persicus, Dactylis glomerata, Trisetum* sp., *Poa* spp., *Agropyron* spp., *Festuca* spp. The forage legumes are more or less the same as those of the medium forest belt, but *Astragalus species* are more numerous. In the drier or more eroded areas, the *tragacanth vegetation* of the high Irano-Turanian mountains appears (*Onobrychis cornuta, Astragalus* spp.). In fact, this is a much more pastoral rather than a forest belt, especially in its upper regions. The rangelands above 2,700 meters belong to the "substeppic-alpine" type and are related to the Irano-Turanian zone.

❖ The Hyrcanian Forest Communities

High species diversity in the region has given rise to various plant communities. The most important tree and shrub communities in the Hyrcanian zone are (Sabeti 1976, Mohajer 2005, RIFR 2006):

- ***Querco-Buxetum:*** This is a plant community exclusive to the Caspian coast plains with permeable sandy soils. Two distinct strata are found in this community. The first stratum consists of oak trees along with species like maple, alder and Caucasian false walnut. The second stratum is very dense consisting of boxwood, Caspian honey locust, silk tree and date plum as well as a ground cover of ferns such as *Pteris cretica* , *Graminae* species and a number of moss species that do not only grow on the ground but also hang from tree branches, giving these forests eye-catching sceneries.

- ***Querco-Carpinetum:*** This forest community is found on the lowlands of the northern slopes in Gilan and Mazandaran provinces, where lower relative humidity is usual. Due to the extensive utilization of the oak trees, the only remaining tree species found

in this community is hornbeam (*Carpinus betulus).* In the drier climate of the North-east, the community gradually transforms into a *Zelkovo -Quercetum* community .

- ***Parrotio-Carpinetum:*** This forest community covers low slopes of the Caspian coast, forming a dense forest structure. In addition to ironwood (*Parrotia persica*) which is the indicator species in the community, grow other species such as *Carpinus betulus*, *Cyclamen elegani* and *Primula heterochroma* . The community has been extensively exploited reaching degradation in many sites. However, it is still a multifold forest association found at a range of different forms .
- ***Fagetum hyrcanum:*** Also called the Hyrcanian beech community is a pure community of beech trees. With *Fagus orientalis* as the main species, it makes up the most beautiful and richest Iranian forests. The standing volume on average has been estimated to almost 600 and in some cases 800 m^3 per ha. Some beech trees grow up to 50m in height with a dbh of 2m. This forest community has remarkable significance due to its high production and economic value. It also has been preserved more successfully as compared to other communities .
- ***Carpinetum orientale***: Along with *Quercus macranthera, Carpinus orientalis* forms this forest community of the Northern Forests that climbs up to an altitude of 3000 m. The hornbeam community consists of short trees with shootings that grew after the trees had been felt. The forests lack considerable economic value. However, they may form an excellent vegetation cover to prevent erosion. Unfortunately this function is remarkably diminished by extensive grazing.
- ***Cupressus sempervirens and Thuya orientalis communities:*** The two species form rather limited relict communities from warm periods and inter-glacial climate, offering habitats to numerous Mediterranean elements. The current climate resembles the Mediterranean climate and the communities are mainly found in the Hasan Abad Valley in Chaloos, as well as the Roodbar Valley and the Soorkesh Valley in Gorgan.

Based on the FWRO statistics (2006), around 37% of the Northern forests have a canopy of less than 50% cover. The inventory also shows that 37% reach an average stand volume of less than 200 m^3 per ha, which is greatly different from the normal production potential. Beech and hornbeam trees compose 54% and 60% of the stem number and standing volume of the Northern Forests respectively. Over the past three decades, species like beech, hornbeam and lime tree have diminished in volume while the volume of ironwood, alder and other

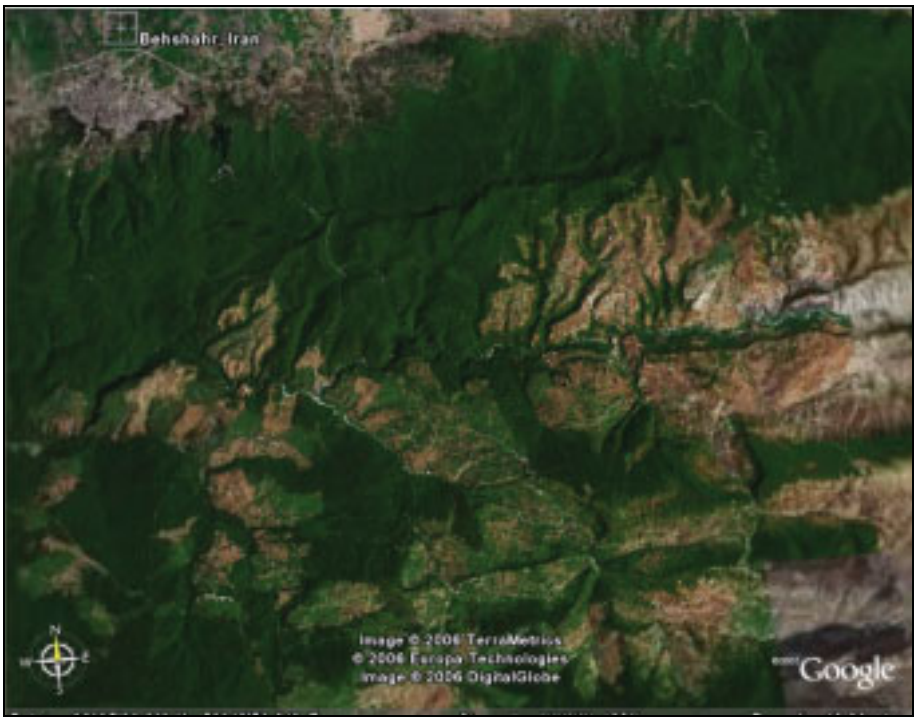
species has increased. Nine percent of the trees in the diameter classes thicker than 60 cm including old and decayed trees account for 50% of the volume. In addition, only 58% of the trees are healthy while the other 42% are suffering damage.

❖ The Yakhkesh Forests

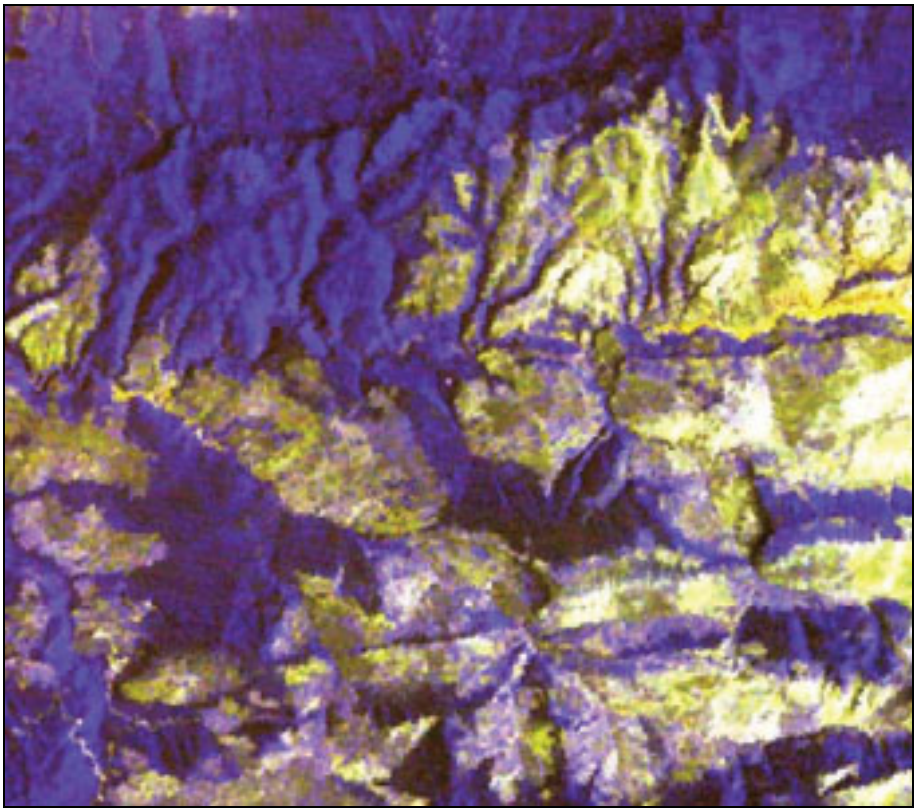
The Yakhkesh forests are located in the Eastern zone of the Hyrcanian region. The area is largely wooded, with broad-leaf deciduous species on the upper slopes and occasional ever-green stands in the lower areas (see satellite Picture 5, Picture 6, Picture 7, Picture 8). The classification of the 2001 Landsat ETM+ satellite image (see Figure 27) shows that forests comprise around 25000 ha (60% percents) of the Yakhkesh area. However, there is only little knowledge about the vegetation type for most areas of the Caspian forests, even in those areas that are under forest management plans. The first reason for this could be the current conditions for the forests, which - as mixed and uneven-aged, are exposed to high anthropogenic pressures which changes their original plant community and let them differ from the potential natural vegetation. The second but more important reason is the FWRO forest classification method, which is used since long time in the preparation process of the forest management plans that aim at timber extraction. Based on this FWRO classification, forest areas are lands with minimum tree canopy coverage of 10 percent or more. The canopy coverage classes for the so-called *"sparse", "semi-dense" and "dense"* forests are determined as 10-39%, 40-69% and 70-100% respectively (FWRO, 2004). With respect to this canopy coverage classification, FWRO (1986 and 2001) further defines three qualification classes for estimating forest quality. These classes are *"degraded"* or *"low-quality"* forests with less than 30% canopy coverage, *"medium-quality"* with 31 up to 70% and *"high-quality"* with 71 to 100%. Such information however, is only available for a small part of the Northern Yakhkesh area.

Thus, the 1:25000 topographic maps (NICC15 1979 based on the aerial photos of 1966) were the only reliable data which could be used for the classification of the satellite images of the Yakhkesh area for this study (Figure 25). Additional information was used from the ground control data (see chapter III), and from the topographic map, which contains the forest areas in sparse and dense classes, arable lands and settled areas and other information, like roads and springs, beside the contour lines.

[15] National Iranian Cartographic Center



Picture 5: A view of the Yakhkesh area on the quick bird image (source: Google Earth 2007)



Picture 6: Study area on a Color composite of the MSS Landsat for 1978

Picture 7: Study area on a Color composite of the Landsat 5 TM images on 19 Jun 1992

Picture 8: Study area on a Color composite of the Landsat ETM^{+} 17 July 2001

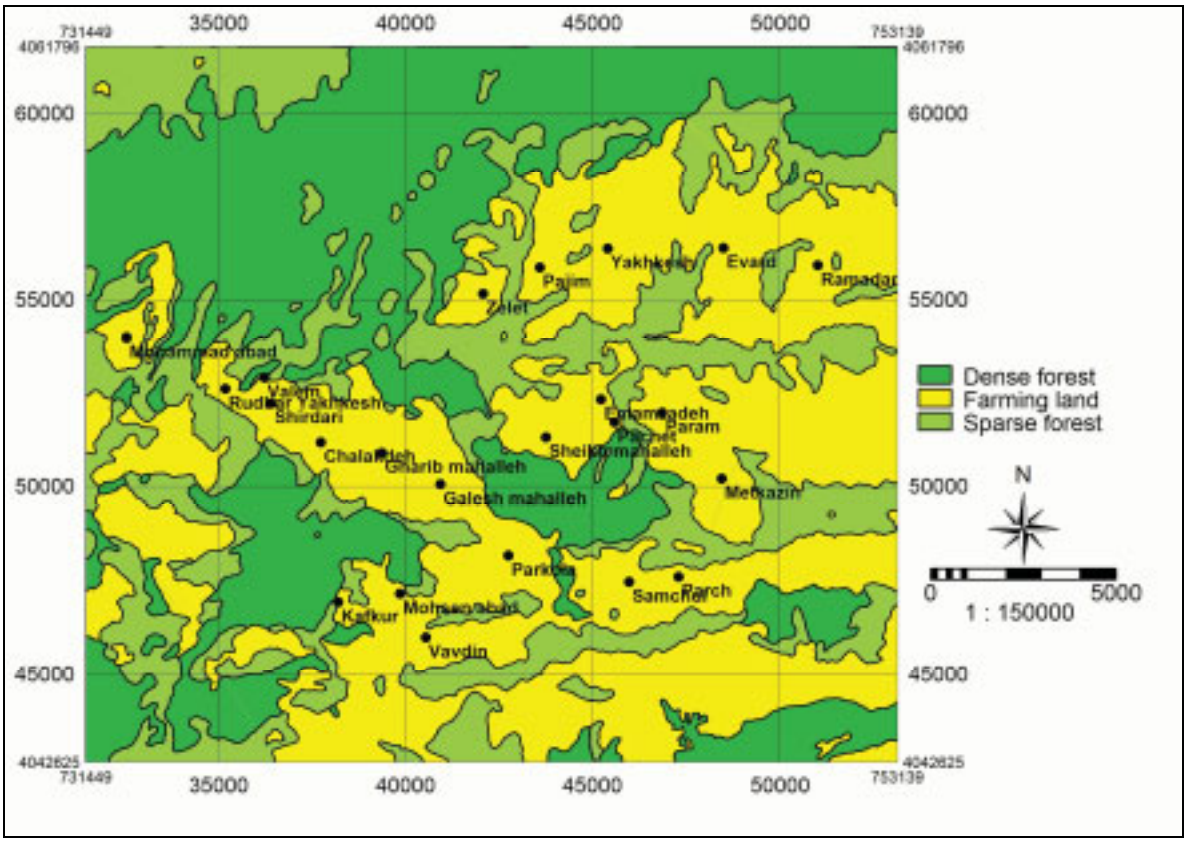


Figure 25: Land use map of the study area, based on the 1965-79 topographic maps, rescaled to 1:150000 as layout (RIFRI, 2001)

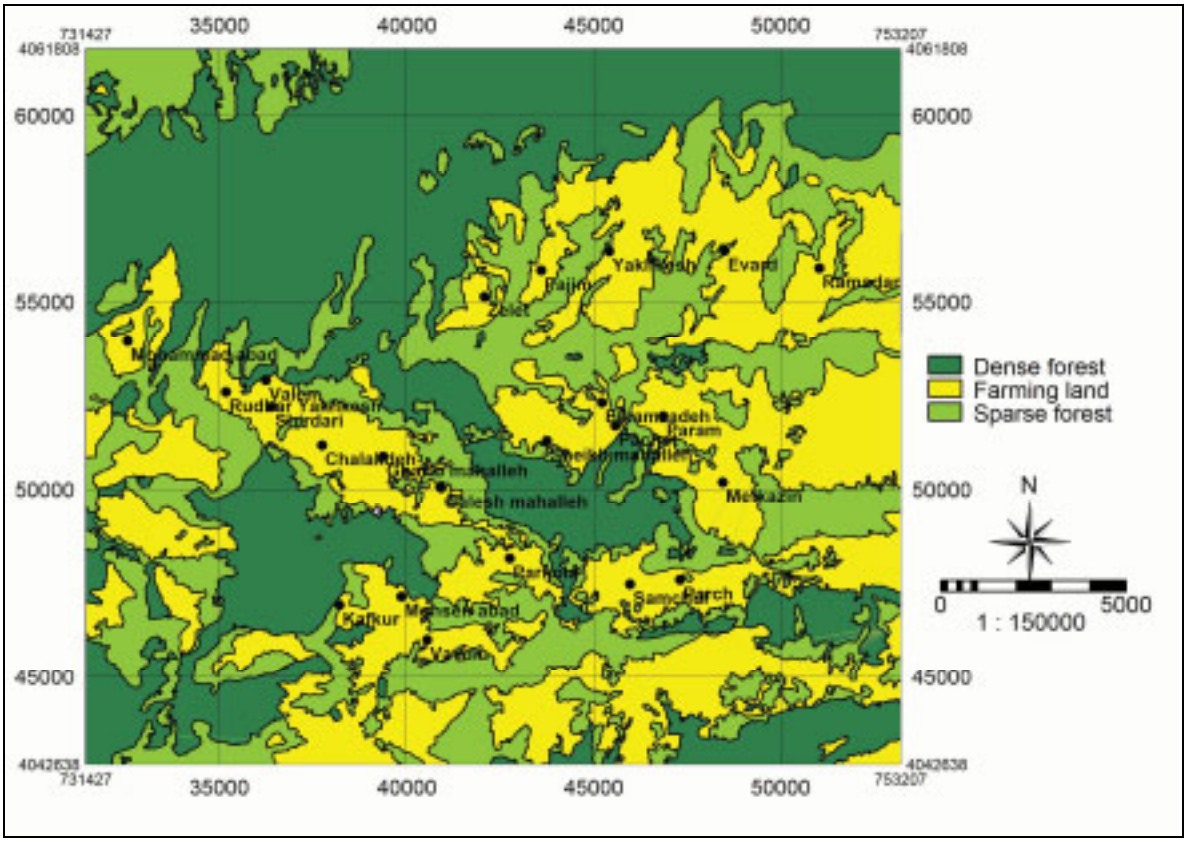


Figure 26: Land use map of the study area, based on the Landsat 5 TM images on 19 June 1992 (Nouri, 2005-6)

The results reveal that the Yakhkesh area covers an area about 41,689 ha which comprises 14,151 ha of dense forest (intact and semi-intact), 10,704 ha of sparse forest (degraded) and 16,665 ha of farmlands and around 204 ha of the settled areas (villages) (see Histogram 8).

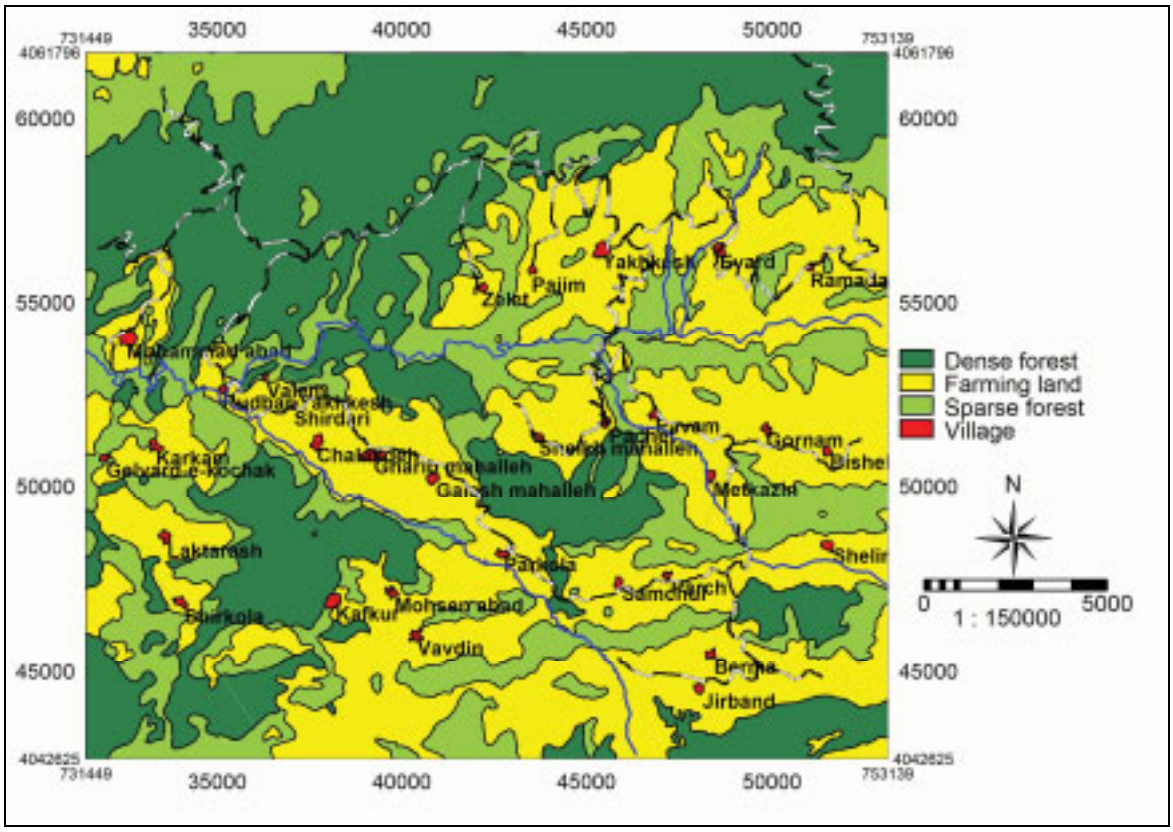
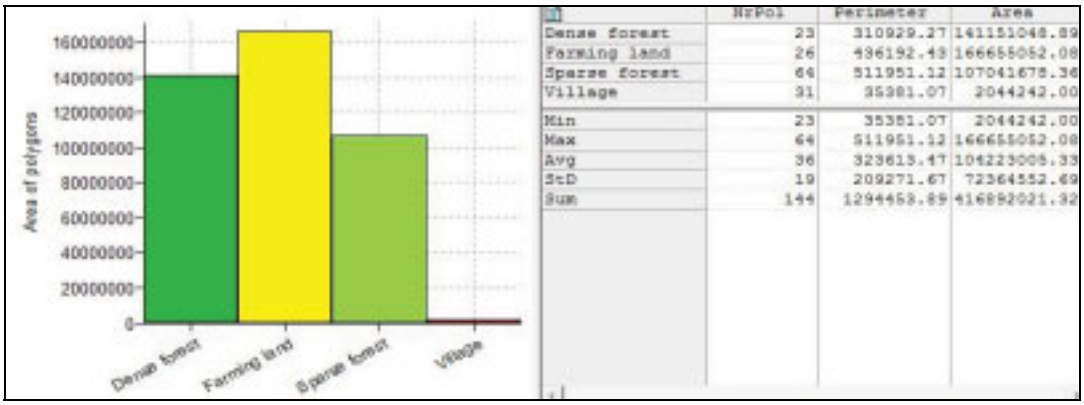


Figure 27: Land use/cover map of the study area based on the Landsat ETM^{+} 17 July 2001 (Nouri, 2005-6)



	NrPol	Perimeter	Area
Dense forest	23	310929.27	141151048.89
Farming land	26	436192.43	166655052.08
Sparse forest	64	511951.12	107041678.36
Village	31	35381.07	2044242.00
Min	23	35381.07	2044242.00
Max	64	511951.12	166655052.08
Avg	36	323613.47	104223005.33
StD	19	209271.67	72364552.69
Sum	144	1294453.89	416892021.32

Histogram 8: Area estimation of the main type of the land use/cover in the study area

Picture 9: Some common views of theYakhkesh forests (Nouri, 2005-7)

The annual growth of forests in the Yakhkesh area is estimated to lie between 2-3 m^3 per year (FWRO-Mazandaran 2001). Based on the information form local experts and the field visits, the Yakhkesh area comprises three of the Hyrcanian forest communities: The *Querco-Carpinetum* and *Carpineto-Fagetum* communities are found mainly on the northern, northwestern and western slopes and cover the major part of the study area. Most *Querco-Carpinetum* forests include *Carpinus betulus* and *Quercus castaneafolia* as dominant species. Beside these species are trees and shrubs such as *Zelkova crenata, Tilia begonifolia, Gleditschia caspica, Ulmus carpinifolia, U. glabra, Ficus carica, Diospyrus lotus, Acer velutinum, A. cappadocicum, Fraxinus excelsior, Cydonia oblonga, Malus orientalis, Pyrus boissieriana, P. communis, Mespilus germanica, Rhamnus grandifolia, Juglans regia* and *Fagus orientalis.* This type is mainly covers the altitude range up to 700 or even 1000m in the Yakhkesh area.

Carpineto-Fagetum forests are dominated by two main species, i.e. *Fagus orientlis* and *Carpinus betulus* that comprise forests between 700 up to 1800 or even 2000 m above see level. These species are usually accompanied by many trees and shrubs such as *Acer velutinum, A. cappadocicum, Tilia begonifolia, Taxus baccata, Fraxinus excelsior, Sorbus*

torminalis, S. orientalis, S. Biossieri, Cerasus avium, Ulmus glabra, U. carpinifolia, Diospyrus lotus, Pyrus Boissieriana, P. communis, Malus orientalis, Euonymus latifolius, E. velutina, Lonicera iberica, L. floribunda, L.caucasica, Laurocerasus officinalis, Coryllus avellana, Berberis orientalis, B. vulgaris, Mespilus germanica, Rhamnus cathartica, Viburnum lantana, V. opulus. Destroyed forests of this type, especially around settled areas are usually replaced by stands of *Carpinus schuschuensis* (in a coppice form) with *Crataegus sp., Rosa sp. and Rubus sp.*

The *Quercetum macranthera and Carpinetum orientale* forests cover only small parts of the Yakhkesh areas, mainly above 1800m altitude, with *Quercus macranthera, Carpinus orientalis* and *Carpinus schuschuensis* as the main tree species Furthermore, valleys and riversides (up to 1000 m) are covered by *Alnetum* forests and which are dominated by *Alnus subcordata*.

From the view of Biodiversity, the Yakhkesh area represents significant components of biodiversity on the both, national and global scales. There are a number of endemic tree species, especially Box tree (*Buxus hyrcana)*, which have extremely limited distributions. Some widespread species are found in unusually pure and undisturbed stands (in parts of the Yakhkesh Mountains). Large, pure and old stands of Yew (*Taxus baccata) and C*aucasian Oak *(Quercus castaneifolia)* are one of such examples. A few stands of Siberian Elm (*Zelcova crennata*) are also present; though in decreasing amounts (see Picture 10 and Picture 11). A list of the important plant species with respect to biodiversity is presented as Appendix I.

Picture 10: Yakhkesh has some quite unique important habitats with respect to biodiversity. Left and right above: very old stand of *Quercus castanaefolia, Taxux baccata and Boxus hyrcanus* in Sheikhnur holy shrine. Below: natural regeneration of *Buxus hyrcanus* in the southern slope of the Mehraban-rood River plant (Nouri, 2005-7).

Picture 11: Very old Yew (Taxus baccata, left, above) and Beech (Fagus orientalis, above middle) specimens in the very sloppy forest surfaces in southern catchment's area of the main river. Caucasian oak *(Quercus castanaefolia*, above right) and beech forest community (below) in the unprotected forests in Ghaleduk near Pachat village (Nouri, 2005-7).

4.2.2 Fauna

Due to the shelter offered by the dense intact forests of the Yakhkesh area, especially in the southern part of *Mehraban-rood River,* both representative and endangered wildlife species of the Caspian mountain forests are still present in this area (see Picture 12).

Picture 12: Some of the important wildlife species in the forest and mountainous habitats of the Yakhkesh area. Above left to the right: Partridge, Fox, Leopard, Forest cat, Bear, Pheasant, Wild boar, Roe Buck, Red deer, Wolf, Porcupine and lynx (sources: DoE 2003, Wikipedia 2005).

These encompass red deer *(Cervus elaphus)*, Roe buck *(Capreolus capreolus),* wild boar *(Sus scrofa),* bear *(Ursus arctos),* rabbit *(Lepus capensis),* golden jackal *(Canis aureus)*, porcupine *(Hysterics indicus)* and endangered species such as the pheasant (*Ephesianus colchicums persists*), leopard *(Panthera pardus)*, lynx *(Lynx lynx)*, jungle cat (*Felis chaus*) and wolf *(Canis lupus*) (UNDP-GEF, 2001).The lack of inventories and scientific studies on wildlife species in the project area however led to a shortage on reliable data, especially about the population sizes of the relevant species. A list of the biodiversity important fauna species is presented as Appendix II. This list was prepared based on collected data from the DoE staffs as well as from the local villagers.

4.3 The socio-economic environment

4.3.1 Population

The Yakhkesh Mountain area is located within the Mazandaran province, south of Behshahr and Galougah and north of the Kusar Rural District (see Figure 28). The Rural Districts of Lali and Shahriari border on the east and west respectively. The project area includes 18 villages amongst which 13 villages are located adjacent to the forest areas, including *Pachat* and *Sheikh-mahalleh* in the North, *Metkazin* and *Parem* in the East, *Parch*, *Samchool*, *Par-kela*, *Galesh-mahalleh* and *Gharib-mahalleh* in the South and Valam, *Shirdari*, *Chalakdeh* and *Roodbar* in the West. The total population amounts to 6060 individuals in 1113 families (1996 census).

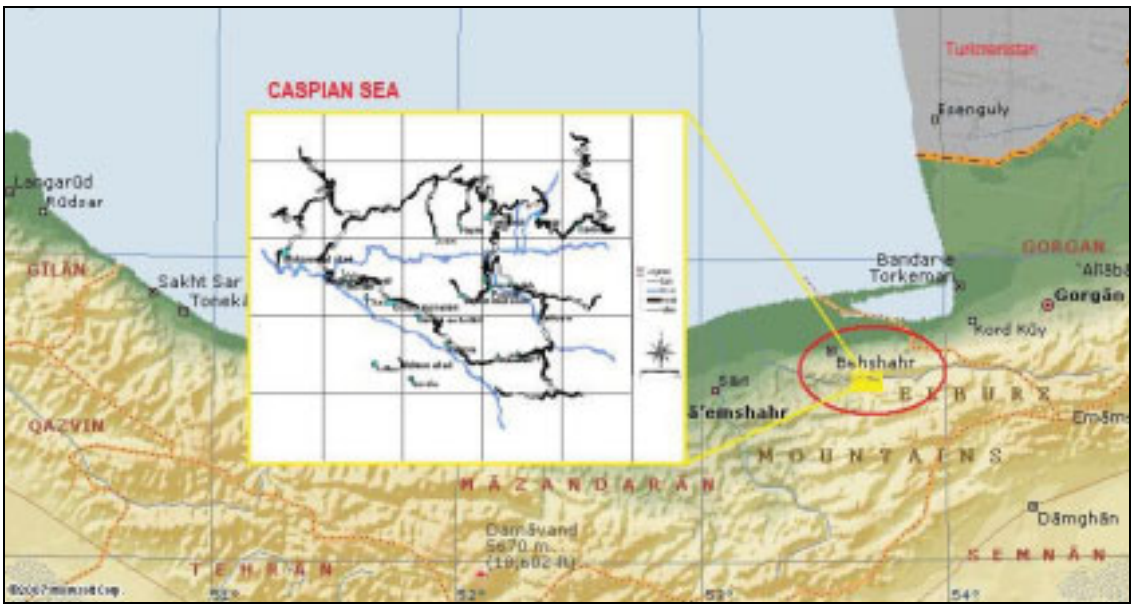


Figure 28: Yakhkesh area in Mazandaran Province, southeast of Behshahr

The villages show great differences in terms of the number and socio-economic conditions of their inhabitants. Regarding population size, the villages can be classified in three categories, i.e. large, medium and small. Evard (836 inhabitants), Gharib-mahalle (758 inhabitants), Mohammad Abad (590 inhabitants) and Evlar (523 inhabitants) include the largest numbers of inhabitants, while Valam (114 inhabitants), Sheikh-mahalleh and Chalakdeh (120 inhabitants) include the smallest number. The population size in other villages ranges between 180 and 400. The average number of inhabitants for each village is 337.

Table 2: Location, population and education in the villages of project area (Source: MOAC Behshar, 2001)

Village	Geographical position		Altitude	Distance from Behshahr	Population Size		Number of literate people	Adults, Primary, Middle, High school
	Long.	Lat.	(m)	(km)	Total	Families		
Evlar (Yakhkesh)	53 45	36 37	1300	38	523	115	291 (55%)	P, M
Evard	53 47	36 37	1320	58	836	160	493 (58%)	A,P,M
Parem	53 46	36 35	1160	52	350	66	192 (55%)	P
Pajim	53 43	36 37	1220	34	434	78	218 (52%)	P
Pachat	53 45	36 35	1100	50	184	45	85 (46%)	P
Par-kela	53 43	36 33	1050	30	497	89	208 (42%)	P,M
Chalakdeh	53 41	36 34	850	34	120	15	60 (50%)	-
Ramadan	53 48	36 37	1140	53	262	46	143 (55%)	A,P
Rood-bar Yakhkesh	53 46	36 37	700	32	176	26	79 (45%)	-
Zelet	53 42	36 37	1220	32	235	44	102 (43%)	A, P
Samchool	53 45	36 32	1260	43	241	48	150 (62%)	P
Sheikh-mahalleh	53 43	36 35	1260	52	120	26	48 (40%)	A
Shirdari	53 40	36 35	810	33	188	27	86 (46%)	-
Gharib-mahalleh	53 44	36 34	970	36	785	130	381 (48%)	A,P,M
Galesh-mahalleh	53 44	36 35	1000	38	146	22	68 (47%)	-
Metkazin	53 47	36 34	1200	47	259	59	120 (46%)	A,P
Mohammad Abad	53 13	36 31	900	34	590	95	194 (33%)	P
Valam	53 39	36 27	840	33	114	22	49 (43%)	P
Total	**-**	**-**	**-**	**-**	**6060**	**1113**	**2967 (49%)**	

The literacy rate indicates the percentage of the people with a minimum level of education (primary school). It ranges form 33% (Mohammad Abad) up to 58% (Evard). The average literacy rate for the total population is around 49%. Table 2 shows the names, geographical locations and other related information of the villages within the project area.

Transport facilities are limited, consisting of one road to Behshahr, which is not navigable during winter. Furthermore, sources of income are very limited and seasonal unemployment is high.

4.3.2 Livelihood System

The inhabitants of the area are predominantly poor farmers. The major livelihood activities are dry farming and cattle raising, which are strongly dependent on the forest resources (see

Picture 13). Major Agricultural products of the region are wheat, barley, millet and rice (along the riversides). In addition, oil seeds, vegetables, fodder and garden products are also cultivated. Traditional cultivation practices are mainly including seed bed preparation by animal and currently by machinery (tractors) force, plantation of seeds (mainly wheat and barley) without or with inappropriate use of chemical fertilizers, irrigation with rainfall (rain-fed farmlands), harvesting by human force and use stems and other by-products for feeding livestock. Table 3 shows some per capita statistics for the main livelihood activities in the project area.

Table 3: Per capita statistics for agriculture and cattle-raising for the main villages of the project area (MOAC Mazandaran 2001)

Name	Population Size		Arable Lands (ha)	Arable land per indi-vidual (ha/person)	Arable land per family (ha/f)	Livestock			
	Total	Family				Cattle	Cattle/ family	Sheep & Goats	S&G/family
Evlar (Yakhkesh)	523	115	1627	3,1	14,1	340	3,0	3200	27,8
Evard	836	160	1170	1,4	7,3	240	1,5	4200	26,3
Parem	350	66	437	1,2	6,6	75	1,1	2200	33,3
Pajim	434	78	625	1,4	8,0	220	2,8	1750	22,4
Pachat	184	45	627	3,4	13,9	160	3,6	2150	47,8
Par-kela	497	89	271	0,5	3,0	360	4,0	4000	44,9
Chalakdeh	120	15	115	1,0	7,7	45	3,0	850	56,7
Ramadan	262	46	535	2,0	11,6	205	4,5	1350	29,3
Rood-bar Yakhkesh	176	26	110	0,6	4,2	80	3,1	1250	48,1
Zelet	235	44	411	1,7	9,3	650	14,8	550	12,5
Samchool	241	48	298	1,2	6,2	130	2,7	3500	72,9
Sheikh-mahalleh	120	26	205	1,7	7,9	250	9,6	1000	38,5
Shirdari	188	27	148	0,8	5,5	90	3,3	2300	85,2
Gharib-mahalleh	785	130	935	1,2	7,2	225	1,7	5250	40,4
Galesh-mahalleh	146	22	160	1,1	7,3	95	4,3	1250	56,8
Metkazin	259	59	172	0,7	2,9	110	1,9	1800	30,5
Mohammad Abad	590	95	580	1,0	6,1	420	4,4	3500	36,8
Valam	114	22	90	0,8	4,1	25	1,1	650	29,5
Total	**6060**	**1113**	**8516**	**1,4**	**7,7**	**3720**	**3,3**	**40750**	**36,6**

The total registered arable land is 8516 ha (MOAC, 2001) which leads to an average of less than 8 ha per family. With an average family size of 5.6 persons, cultivated land averages barely over 1.5 ha per person. Due to the weak nutrient content of the soil and leaching, farmers fallow their farmlands, specially the sloppy ones, for three years to compensate the weak fertility of the soil. Therefore, the overall agricultural productivity is below average (0.6 up to 1.5 tons/ha for wheat and barley). Among the villages, Evlar (Yakhkesh) with 1.627 ha and Evard with 1.170 ha, have the largest cultivated areas (see Table 3 and Histogram 9). Although Evlar has the maximum per family average of the cultivated area (14.1 ha/family), Pachat has greater per capita averages (3.4 ha/person) among other villages in Yakhkesh area.

The total income from wheat and barely cultivation in the Yakhkesh area is estimated, based on the current prices (2007) for ploughing, fertilizers, pesticides, etc. as follows:

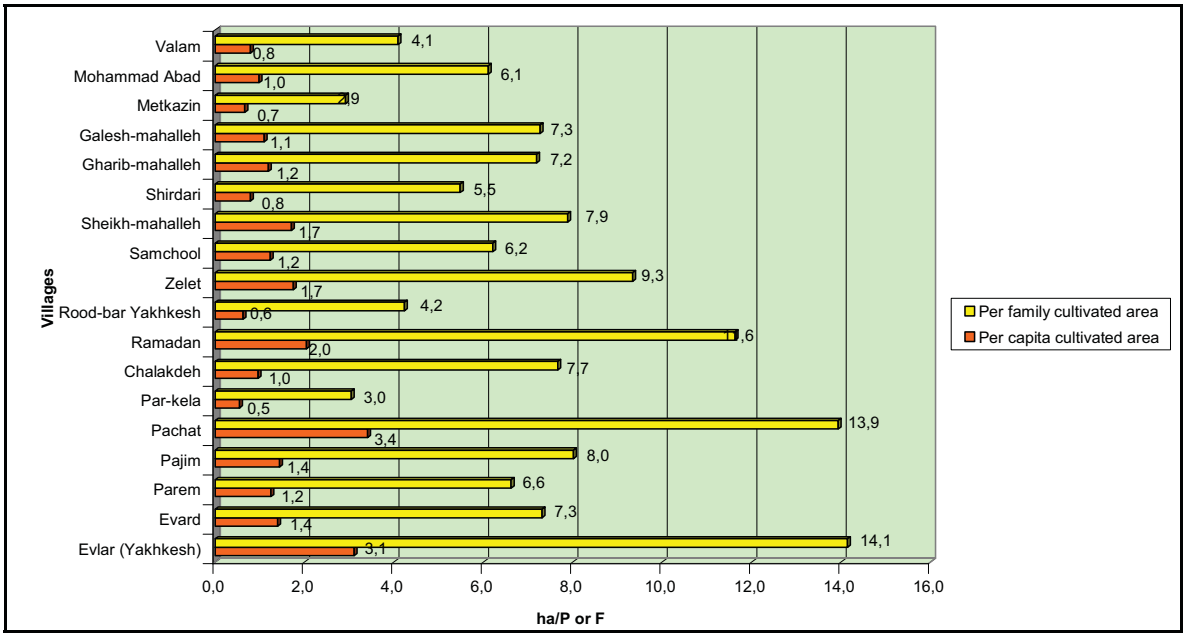
- seeds:	690 k Rials/ha
- ploughing and disking:	300 k Rials/ha
- fertilizers (not usual):	150 k Rials/ha (for Ammonium Nitrate)
	+ 300 k Rials/ha (for Ammonium Phosphate)
	+ 100 k Rials/ha labor
- pesticides (unusual):	320 k Rials/ha + 200 k Rials/ha
- packing:	30 k Rials/ha
- transport:	90 k Rials/ha
- others:	120 k Rials/ha
- **total costs:**	**2.200 k Rials/ha**

On the other hand, the total yield for wheat in the best condition is estimated to range between 1.5 up to 3 tons/ha (hardly 0.6 ton/ha in the low yield sloppy farmlands), which is then sold with a price of around 2.050 Rials/kg to the Government or around 1.600 Rials/kg to the middlemen. Therefore, the total income from wheat cultivation as the main crop should be around 30.700 to 6.150 k Rials/ha. By deducting the total costs from this income, the net income would be around 875 to 3.950 k Rials/ha which equals 95 to 430 $US/ha[16]. Since the average arable land for each family is around 7.7 ha, each family might expect a net income between 731 and 3.311 $US per annum, which appears to be rather optimistic. In fact, the results of the field studies in 2005 and 2007 revealed that the per family income from

[16] Based on the current exchange rate, 1 $US is equivalnet to 9190 Rials (November 2007)

agricultural activities ranges from 1.000 to 8.000 k Rials with an average of 3.343 Rials per year, which equals around 110 to 870 $US and an average of 490 $US per year.

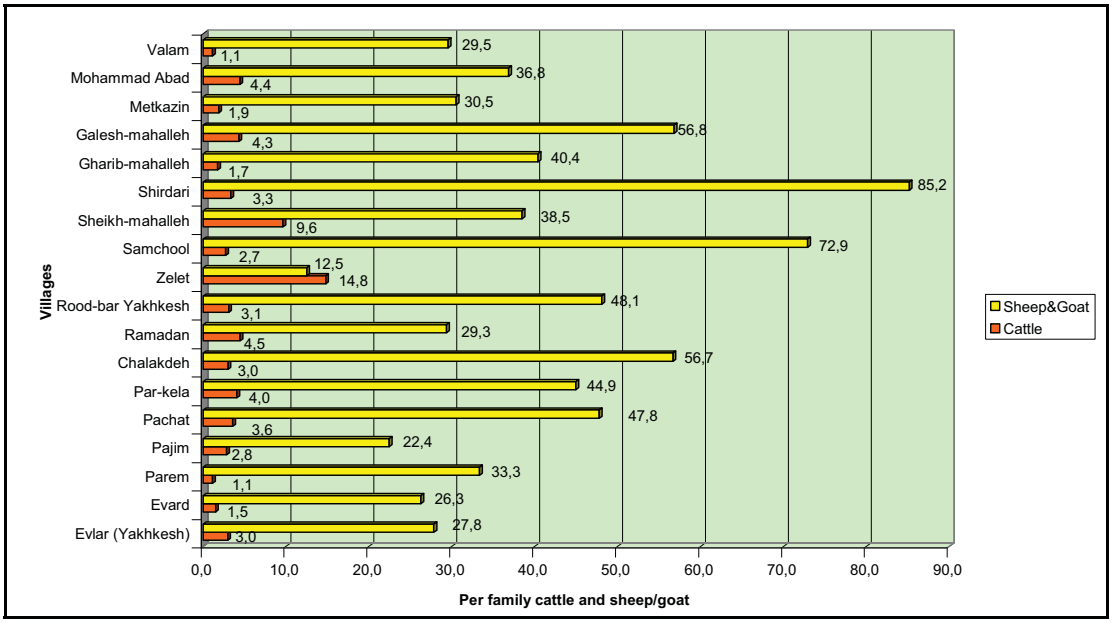
Picture 13: Continuous forest conversion to the sloppy farmlands (Nouri, 2005-7)



Histogram 9: Per family and per capita averages of the cultivated areas in the study area (MOAC Mazandaran, 2001)

The villagers in the project area raise cattle, sheep and goats as a complementary source of income (see Picture 14). In 2001, the total livestock population in the project area was 3.720 cattle and 40.750 sheep and goats (Ministry of Agricultural Crusade, MOAC, 2001). Among the villages, Zelet with 14.8 and Shirdari with 85.2 have the greatest per family averages of the cattle and sheep/goats in the project area (see Table 3 and Histogram 10).

Picture 14: Cattle raising on the forests and marginal lands (Nouri 2005-7)



Histogram 10: Per family and per capita number of the livestock in Yachkesh (MOAC Mazandaran, 2001)

In the traditional system of animal husbandry, indigenous but low efficient races of livestock are pastured in fallowed farmlands and forest areas, where available. Based on the results of the filed studies in 2005 and 2007, the per-family income from livestock raising ranges from 1.000 to 8.500 (average 3.186) k Rials (around 110 to 925 $US) per year. In fact, the traditional system of animal husbandry in the mountain forests is completely dependent on the forest, as the main source of fodder and foliage.

The total income of a family in Yakhkesh area (from agriculture, cattle raising or the both activities) ranges from 1.000 to 13.000 (average 6.528) k Rials (around 110 to 1.415 $US) per annum. This is not the total of both calculations because for some interviewees, cattle raising was the only source of income.

Fuel wood remains the primary energy source in the project area, primarily due to a lack of access to affordable alternatives. At present, there is no single fuel depot or distribution center in the entire Yakhkesh area and electricity supplies are limited and expensive. The per capita annual consumption of fuel wood for each family in the area has been estimated to be around 10.13 m^3 (Yakhkeshi, 2002, Nouri 2005). As a result, the local community depends heavily on wood and charcoal for domestic use and firewood.

4.3.3 The planning and management responsibilities

The institutional responsibility for the management of the Yakhkesh forests lies with the Provincial FRWO of Mazandaran. At the provincial level, the FRWO undertakes programs for the preparation of forestry plans, relocation of livestock herds, which have encroached into forest areas and general conservation and forest rehabilitation activities. However, these tasks can only come to practice through implementation of the forest management plans. So far, such plans have been prepared and implemented for a part of the Yakhkesh forests in the Northern areas of the Mehraban-rood River. These include the “Tirtash-Galugah” forestry plan in a part of the North and Northeastern areas and the “Pajim” forestry plan in the Northwestern and Western area. Protecting the forests, which have no forestry plan (like southern areas of the River) is only limited to the daily or weekly patrolling by the FWRO’s guards. This is a task, which is hardly achievable in the remote mountainous areas like Yakhkesh. The FWRO has maintained a small guard station in Yakhkesh for over 30 years, under the supervision of the Behshahr Forest management Office. FWRO-Mazandaran is also responsible for watershed management, erosion control and the management of the hydrological regime

through planning and implementation of mechanical and biological measures (construction of check-dams, grazing management and rehabilitation of the grasslands, etc.).

The provincial DOE of Mazandaran (Department of the Environment) is responsible for the protection of wildlife species and their habitats, particularly against illegal hunting and habitat destruction. However, the Yakhkesh area is not a DoE protected site, but it is located at the adjacent of the new-established protected area (since 2004) of *Hezar-jarib* in the Mazandaran Province and also of the Meeyankale wetland, one of the important RAMSAR sites in Iran.

The Agricultural and animal husbandry management and rural development activities under the supervision of the Mazandaran Provincial organization are undertaken by the MOAC Behshahr. Starting in the 1990s, MOAC has implemented the "Tuba" plan, which aims at combating forest conversion and soil erosion. This plan promotes villagers to change traditional wheat and barely cultivation on the sloppy farmlands to the fruit gardens by providing free sapling and financial supports.

CHAPTER V

RESULTS

The following results of the exemplary study in the Yakhkesh area, which are presented in this chapter follow the order of the *Sustainable Landscape Planning* procedure as drafted in chapter III and presented in Figure 10. First, the results of the interviews with the both, local people and local experts are described. Then, a root-cause analysis is made to identify the major and underlying causes of the forest loss in Yakhkesh area. The third section presents the results of the ecological suitability assessment using the Iranian (Makhdoum 1988-2002) and German approaches. The final section, again described the second social assessment, which focused on the alternatives and solutions form the view of the both experts and villagers.

5.1 Community assessment

5.1.1 Interviews with the local people

The analysis of the interviews came to the following results:

❖ The group of interviewees

The total number of the interviewees was 60 persons, of which 8.3% were under the age of 30, 36.7% were between 31 to 40, 23.3% between 41 to 50 and 31.7% over 50 years old. Due to the special restrictions in rural areas, especially religious believes, all of the interviewees are men. Only 2 percent of the interviewees were graduated from universities, while 3 percent had high school diploma. The major part (56%) had elementary school education and the rest (39%) were illiterate.

❖ Current livelihood

Most of the people are living under very harsh conditions. Poverty and the low levels of education, living standard and technology, even compared to similar rural areas downstream, led to an accelerating migration (more than 1.5% per year, Census 1996) of the younger generations to the adjacent cities. The average income from cultivation and cattle raising activities does hardly reach 1.400 $US per annum, which can only provide a subsistent level of living for most of the villagers. Around 80 % of the villagers are not satisfied with their current livelihood system and believe that the traditional living system cannot bring a secure economic future for the next generation. Although 75 % of the interviewees think that they will stay their whole life in their villages, 70 % were not sure about such a future for their children. The statistics for the Mazandaran Province shows that the proportion of rural population decreased

Picture 15: Interviews with the local villagers and cattlemen should be carefully done, due to the lack of trust, different customs or cultural constraints

Picture 16: Interviews with local experts and managers

from 58.5% in 1986 to 52.9% in 1996 and to 47.9 % in 2005, with a total growth rate of 0.06%, compared to a 2.24% growth rate for the urban population. This means that the productive part of the rural population gradually decreases and adds to the urban population. So far, this has resulted in lots of social conflicts in the urban areas, while threatening food security on the both regional and national levels. On the other hand, the destructive impacts of the traditional cultivation system have been exponentially increased during the first decade after

Islamic Revolution through some wrong policies of the Government for providing agricultural machinery, especially tractors, for the rural society, without attention to the needed cultural and technical capacity buildings. This in company with the weak monitoring and control measures of the new-established Government led to a disaster, especially in the upper parts of the watersheds, where sustainable forestry and conservation of the soil and water are necessary for preventing downstream against flood events. During the past two decades, deforestation in the upper parts of the watersheds led to more than 6 huge flood events in the Caspian Region, and two of them happened in the adjacent areas of the Yakhkesh area (Neka flood in 1999 and Golestan flood in 2001).

❖ Basic needs and expectations

The interviewees announced their main expectations and basic needs from their environment and its natural resources (forests, pastures, rivers, landscapes, etc.) as follows:

- Cultivation and creating new farmlands (more than 95%)
- Grazing of the livestock (around 87%)
- Collection of firewood and charcoal production (more than 90%)
- Timber for domestic use (more than 95%)
- Forest by-products (around 65%)
- Hunting (around 45%)
- Healthy water for domestic use and agriculture (more than 75%)
- Amenity values and recreation (around 40%)
- Settlement (around 76%)

❖ Attitude towards the legal framework for environmental protection and natural resources management

Around 75 % of the interviewees believed that the current legal framework for environmental protection and natural resources management is fair and could secure and protect their rights for proper utilization of the natural resources, especially forests. However, they also stated that this legal framework has never been properly used by the responsible Government organizations (mainly FWRO) or has even been misinterpreted against villagers and their cattlemen rights and benefits. For example, the FWRO did recently cancel the traditional rights

of the villagers in the forest areas to use domestic timber, to collect firewood and to let graze their livestock. This led to huge conflicts in villages like Zelet, Pajim, and others, which are completely dependent on the forests, especially for firewood. Thus, people illegally plunder their forests, which before have been legally used in a semi-sustainable manner. Around 67% of the interviewees admitted that they had a legal problem with government organizations, and around 80% stated that the current penalties and punishments were unfair and could not prohibit illegal activities, which rooted in the poverty or lack of alternatives and awareness.

❖ Attitude towards Government organizations and programs

In an overall view, the rural communities have no trust in the government organizations. To a certain extend this may result from the lack of environmental awareness, low education levels or poverty. Above all, it seems to be a consequence of the weak results of the most previous development programs, which could not significantly improve the socio-economic conditions or bring fair solutions for the conflicts and challenges. Due to the inappropriate and undemocratic nature of the agriculture and natural resource management, people are very suspicious against new ideas, especially those, which come from the government. The dominant top-down sector planning and management system pays little attention to the interests of the villagers, neither in the planning nor in the decision-making process. Around 73% of the interviewees announced that they did never have a chance to take a decision about these programs, which directly affect their life. In most of the previous projects, community participation has been misused as a propagandistic instrument to cover the weaknesses or magnify the feeble results of such programs. Around 75% of the people underlined their dissatisfaction with the Governmental programs and activities for the rural development, for agriculture, animal husbandry, forestry, watershed management and public awareness.

The major weaknesses of these plans were mentioned by the interviewees as follows:

- *Forest management plans:* conflicts with the livelihood system (85%), little initiative to use the local labor forces (65%), assignation of the economic benefits to private companies and to the government rather than to the local people (91%), and forest destruction by the private companies due to a lack of monitoring and weak control (88%)
- *FWRO livestock management plan:* lack of financial, technical and administrative supports (73%), compulsory form of the plan (95%), promotion of illegal activities

(67%) and migration of the labor force to the cities with related social problems (71%)

- *Orchard development on the sloppy farmlands (Tuba plan by MOAC):* weak financial and technical supports (67%), inappropriate operational program (70%), little attention to the basic needs of the rural society (73%)
- *Propagation activities and training classes:* short-term framework (78%), great emphasis on theoretical rather than on practical aspects (75%), little attention to the traditional knowledge and experiences (53%)

However, the implementation of the UNDP-GEF project in the Yakhkesh area could re-establish trust and confidence among the affected rural communities. This was mainly due to the high social acceptance of the project manager and his staffs among the participating rural communities; and it was further enforced by a strong propagation and training program and technical supports.

Until the year 2005, the people in the Yakhkesh area participated in the following programs:

- Rural development (43% before the UNDP-GEF project, but 65% after)
- Agricultural development and mechanization (49% before, but 61% after)
- Animal husbandry (42% before, but 58% after)
- Forestry (22% as forest guards or for timber-extraction, but 85% in afforestation activities of the UNDP project)
- Watershed management (33% for grassland rehabilitation and cultivation of the fodder crops, 66% after just for alfalfa cultivation)
- Propagation and training programs (45% before, but 85% after)

The villagers mentioned the following major reasons for not collaborating:

- Lack of confidence or trust in the suggested activities or the project staffs (86%)
- Lack of time, money or other personal excuses (66%)
- Challenges with other stakeholders (38%)
- Lack of motivation, financial helps or subsidies from the government (83%)

Nevertheless, around 70 % of the interviewees said that they were eager to cooperate in the planning and management programs of the government organizations. However, more than

85% preferred those programs, which follow a participatory approach, do have enough financial and technical supports and look promising in bringing them significant economic benefits. The UNDP-GEF project has shown that financial incentives can play an important role in encouraging the villagers' participation. Additionally, continuous training workshops, by local experts, can increase awareness and imitative among rural community members.

❖ Decision making

So far, democracy is not properly developed in the rural society of Iran. Iranian sociologists called it a "Flock Society" (Nooriala, 2007), which prefers obeying its politicians, religious leaders, rich men or at least following the greater part of the society, rather than taking decisions individually or trying to influence this process by active participation. The villagers endured all the government programs, but showed their objections by obstruction. For example, many villagers are participating in Tuba plan, just for using the loans from the agricultural bank or for getting free fertilizers and other incentives. However, when they received the money or other support, they do not see any reason to follow the program. The lack of monitoring and inspection promotes such misuses.

At first sight, it seems too difficult to motivate and organize such a people for decision-making or for any kind of participatory work in the related projects. However, there are innovative opportunities, which could be created, either derived from the traditional utilization system or from the successful similar projects in other countries. For instance, the traditional system of cattle rising defined special territories for each village. In fact, each village has its specific forests for timber, firewood and grazing, which are always respected by the neighbors. Even now, four decades after nationalization of the forests and grasslands, villagers still respect their traditional territories, which have always been neglected by the government organizations or private contractors. Furthermore, the great potentials of the youths and women, which have always been neglected, could play an important role in higher acceptance and better implementation of the governmental programs.

❖ Opinion about forest ownership

Around 95% of the villagers expressed the opinion that the forests should be affiliated to the rural societies, based on their traditional territories but under supervision of the government. Around 93% of the interviewees were convinced that illegal logging increases, when foreign contractors come to cut "villager's trees". .

❖ Satisfaction

The villagers did not express any kind of satisfaction with their previous and present economic and ecological conditions. The lack of alternatives, which could be elaborated in the form of an integrated but perceivable plan, is the main cause for the persistence of such ineffective and destructive land uses in the area. Due to the natural weakness of the mountainous sites for cultivation, the traditional living system is highly dependent on the forest resources. This, however, led to an increasing degradation of the vegetation covers, to soil erosion, water shortage and flood events, especially during past 2 decades. Around 73 % of the interviewees believed that their future life would be threatened by these environmental problems. Only 43% of the villagers accused the rural communities as the major destructive actors for forest degradation in the mountain areas, while 65% accused the government, 68% the private contractors and 59% illegal loggers.

5.1.2 Interviews with the local/regional managers and experts

One of the main topics of this research program is also to gain the ideas, criticisms and comments of the local experts in the related branches of the Government or private sectors about the legal framework, as well as, the past and current planning and management system of natural resources in the mountain forests of the Caspian region. Two decades after the introduction of the principles of land use planning in Iran, most of the government bodies have developed their special planning and management systems, which are however more sectoral than integrated. In fact, there are many overlays and conflicts among the basic principles and ultimate goals of the different sectoral plans, due to an ineffective and complex top-down planning and management system. The respective programs devour a lot of money on both national and provincial levels, but the results mostly remain theoretical. Planning and management on the local scales is a permanent challenge among government organizations and the rural communities. Most of the interviewees emphasized the necessity of an integrated but practical management system, which should be developed based on local expertise and experiences. (Picture 16)

Thus, capacity building could be a very important duty of the government, especially on the provincial and local levels. However, the lack of an effective and democratic management

system, as well as, low salary levels and non-monetary incentives prohibit any active participation.

The first part presents the group of interviewees and the level of job satisfaction. The results are summarized as follows:

❖ The group of interviewees

- *Age and sex:* The total number of the interviewees was 53 persons (85% male and 15% female), mostly under the age of 40 (81%; with: 19% under 30 and 62% 31-40); only a smaller portion was older than 40 years (11% 41-50 and 8% above 50).
- *Field of expertise:* 26% were educated in forestry, 38% in environmental sciences, 11% in grassland and watershed management, 9% in agronomy and 9% in other fields of sciences.
- *Working background:* 32% had been working for 5 years or less, 28% between 6-10 years, 28% between 11-20 years and 11% had 21 years or more working experiences.
- *Job's category:* 62% were working in education and research, 4% on managerial levels and 42% as experts or consultants
- *Job's relation to the study field and level of satisfaction with the quality of higher education (HEQ):* 83% had jobs that were closely related to their study field and were satisfied with the education quality, 11% had related jobs as well but were not satisfied with HEQ and 4% had no related jobs but still were satisfied with HEQ

❖ Job satisfaction

A 75% of the interviewees were satisfied with their tasks and duties, 70% expressed their satisfaction concerning their relationship with their colleagues and, 64% were satisfied with their customers. Dissatisfaction was expressed with respect to the current salary: 57%, the relationship with superior managers: 57%, and the lack of needed equipment or facilities: 57%. A 51% complained that no attention was paid to their opinions or skills in their working environment. Nevertheless, 60% preferred to keep their current job and did not want to change the field for a higher income.

The second part focused on the participants' ideas on the legal framework, deficiencies, policy and decision-making, task overlays and inter-sectoral cooperation among different government organizations. The results of this part can be summarized as follows:

❖ Attitude towards the legal framework for environmental protection and natural resources management

Only 8% believed that the current framework was perfect but that there was no guarantee for implementation, 72% judged that it was not a proper framework and should be revised based on the new environmental, political, cultural, social and economic needs and priorities of the country. A 25% thought that the legal framework in Iran was not important at all, because everybody could interpret it according to his own benefits or break it without facing severe consequences.

A 51% of the experts believed that the approach for EPA and its subsets was out of date, and 70% criticized that it put all the responsibilities to the government rather than on the society. A 58% believed that it focused more on the consequences rather than on the root-causes of the problems. The interviewees also mentioned that there was only little attention paid to the needs and expectations of the society in the developing process of the policies and laws. Furthermore, they complained that there was no guarantee for implementation and that the government organizations usually had no respect for the law.

❖ Opinion about the inter-sectoral cooperation (OMIC) between related governmental organizations

A quick look on the history of the natural resources management shows that all of the current organizations have been either separately established or developed to operate in a completely sector-based manner. So far, organizations like DoE, MOAC and FWRO have tried to keep their power on their tasks and duties, which sometimes cover similar goals and objectives. For instance, 68% of the interviewees believed that FRWO and DOE do have task overlays. Such problem was also mentioned to exist between the FWRO and the Cultivation Dept. of the MOAC (34%), the Animal Husbandry Dept. of the MOAC (4%), the Soil and Water Dept. of the MOAC (25%), the Land Affiliation Organization and even the municipalities on provincial and township levels (32%). Therefore, inter-sectoral cooperation, as a part of stakeholders' consultation, is a new subject, which has been mainly come into consideration after the implementation of some UN projects (mainly by UNEP and UNDP) in Iran. The major

part (79%) of the interviewees believed that there was no OMIC anticipated in the legal framework. However, 17% believed that there were a few, but that they needed to be activated. Some of the interviewees stated that the current legal framework needed an infra-cooperation mechanism for solving the challenges and facilitating the cooperation among the related organizations. We also asked the participants to name the main reasons for the weak inter-sectoral cooperation among MOAC, FWRO and DoE. They decided for "dominant sector planning procedures" (49%) as the most important reason and for "competition among related organizations" (45%), "weak capacity building" (38%) and "lack of proper operational programs" (38%), as other main reasons. Recently, the former Forest and Rangelands organization joined the Watershed Management Department of the MOAC, as the new established "Forests, Watershed and Rangelands Organization". A 43% of the interviewees believed that this increased the power of both organizations, while it decreased the task overly. However, 38% also suspected that there was no difference between the previous and the present situation of the both organizations. We suggested a similar reunification for the FWRO, DoE and MOAC departments under one Ministry, but 51% of the participants did not believe that such an idea could succeed. A 9% thought it was necessary but impossible to be realized under the current conditions. Another 38% found it possible and quite necessary in order to facilitate an integrated planning and management process, as well as to decrease task overlays, competition, time and budget. Some of the participants were convinced that only DoE and FWRO could merge, but that the Agricultural Ministry should act independently. Nevertheless, 58% believed that FWRO should act as an independent organization from the MOAC.

❖ Ideas about a proper process for policy and decision-making (PDM)

We also asked the experts for their view about an optimum PDM process in environmental protection and natural resources management and the role they would provide for the Government and the society. Only 2% of the experts believed that the government alone should make policies and decisions, while 47% believed that it should be made by the government but be implemented in close cooperation with the society. Another 11% preferred that decisions should be taken by the society in a true democratic process and should then be implemented by the government, while 49% were convinced that only knowledgeable experts could fulfill this duty, because the people had no appropriate knowledge and usually preferred short term economic benefits rather than long term ecological safeguard. Some of the participants suggested that a triangulated approach should be used by close participation between the gov-

ernmental experts, individual experts (universities and research centers) and community representatives.

❖ Attitude towards the current process for policy and decision-making (PDM)

When asked to judge about the current PDM process in their organization: 79% of the participants stated, that the top managers exclusively made it and that there was no opportunity for any revision or improvement from lower administrative levels. An 11% thought that it was done by special studying groups based on the priorities and needs of their organizations. Although 26% believed that, the PDM process was knowledge-based, 70% saw it primarily political-based without any long-term view and a few others stated that it was at least affected by the political priorities.

It is clear that any change in the top managerial levels might result in a huge change of the previous policies and programs. For instance, FWRO has changed its policy for the Caspian forests for several times. Especially after huge floods, the priorities shifted, whether it should to be used for timber extraction or just be protected for soil and water conservation (Nouri, 1999).

❖ Chances for improvement of the current planning disciplines by public participation

A 28% of the experts suggest public participation for the improvement of the current socio-, economic and cultural development plans, 51% for the sustainable development programs, 43% for the land use planning, 51% for the rural development programs, 42% for the agricultural development programs, 36% for the animal husbandry plans, 45% for the forestry plans, 40% for the grassland management plans, 47% for the protected areas management plan, 38% for the watershed management plans, 34% for aquaculture and 55% for eco-tourism programs. Therefore, participatory planning and management urgently needs strong capacity building on the government as well as on the society levels.

❖ Opinion about forest ownership

Regarding this, we asked the participants to give their opinion about affiliation of the forests to the local communities. Fortunately, 70% thought that was possible and necessary, but that the necessary administrative, social and economic supports should be provided.

The third part of the interviews, focused on the expert's ideas regarding different aspects of the current planning approaches for land use planning and natural resources management, as well as on their experiences concerning some past and previous plans on livestock management, rehabilitation of the sloppy farmlands and related training and propagation activities in Iran. The results are as follows:

❖ Familiarity with integrated landscape planning on different scales

A 74% of the participants believed that it was quite necessary to have a system for national, regional and local planning. Although, 91% thought that such system should be integrated, 6% believed that the planning on the different spatial levels should be made separately for each sector. For most of the government experts *Integrated Planning* seemed to be an ambiguous term, which was usually interpreted with respect to familiar procedures or approaches, such as forestry, watershed management or agricultural development. In fact, most of the experts and local staffs of the relevant governmental organizations have no clear idea about integrated landscape planning and management procedures. The current sustainability principles of *Landscape Planning* even seem a new subject to them. However, 60% of the participants announced to be familiar with the procedure of environment-based land use planning of Iran.

❖ Mentioned weaknesses concerning the current land use planning procedure

The main weak points were referred as: Data quality and quality management of the out puts (53%), improper planning scale (31%), practicability of the results for the experts and the local people (63%), incompatibility with other sector-planning procedures (34%), lack of stakeholders' participation (47%) and, low objectivity (44%). A few criticized the process as theoretical, which could not reach its goals and objectives due to the lack of capacity building and awareness of the real problems in the responsible organizations.

❖ Reasons for improper implementation of the land use plans and chances for improvement by public participation

Since there is not a single LUP, which has been implemented completely, we asked for the main reasons. 31% of the experts accused the lack of legal mechanisms, while 63% thought that the dominancy of sector planning was the main cause. A 25% of the interviewees mentioned a lack of knowledge among managers and experts, while 38% criticized the impracti-

cability of the results, or the weak public participation in the, planning and implementation phases (44%). Some interviewees emphasized that any change in land use might negatively affect economic conditions of the poor rural communities, especially on the local scales. Thus, any suggested activity needed additional financial and technical supports from the responsible organizations. Thus, we asked if the process of LUP could be improved by public participation. Again, the experts stated that they would prefer public participation to strengthen the practical aspects of the plan rather than the planning process itself. They believed that community participation might improve the process of data collection (38%), data processing and analysis (9%), ecological and socio-economic assessment (9%), developing of the scenarios (53%), decision-making between alternatives and between different land uses of the scenarios (50%), as well as the developing of the operational programs (56%).

❖ Mentioned weaknesses concerning the Forestry Plans

For centuries, the local communities did develop a special system for forest utilization, in which each village had its special areas for timber-extraction, firewood collection, hunting and cattle raising. In spite of the fact that the forests have been nationalized and managed by the Government, villagers still do respect their traditional system of rights and ownership. In fact, villagers are the most important protectors of their environment, pasturelands and forests. Private contractors, who are selected by the FWRO for timber-extraction have no idea about or pay no attention to these traditional rules and boarders. For contractors, it is a legal process that should be managed in an economic way to bring maximum benefits. For the rural society, however, it is an unfair process, which does not bring any benefits but leads to the loss and miss-use of their properties. With respect to their domestic uses, the villagers cannot accept the new and apparently arbitrary boarders of the forestry plans that cause many problems for the both, FWRO and villagers (FWRO, 2007). The multifold legal and illegal activities of the private contractors, the rural societies and the wood-smugglers led to an over-utilization of the forests.

A 25% of the experts believed that the current forestry plans did not meet the needs and principles of integrated planning, while 23% criticized it as a top-down procedure with weak stakeholder participation. However, 15% also referred the low access to the up-to-date data or to modern technologies as a weakness and 38% believed that the Forestry Plans focused more on the economic aspects than on the ecological functions of the forests. Another 30% mentioned the weak monitoring of the execution process, which hinders finding and then remov-

ing the restrictions or negative impacts of the forestry plans on the socio-economic or on the natural environments.

❖ Overall assessment of the FWRO Livestock Management Plan

The livestock management plan is supposed to encourage cattlemen to exit their livestock from the forest areas and migrate to the downstream. Only 2% of the interviewees thought it to be a good plan, neither in the developing not in the implementation phases. A 19% judged it as good but believed that it needed further financial and administrative supports. However, 66% evaluated it as an ineffective short-term measure that failed to reach its goals and objectives but caused many socio-economic problems. In fact, it is unusual to prepare a plan at large scale, without any pilot phase or initial assessment or even enough financial supports. Unfortunately, this is what exactly happened for the FWRO livestock management plan in the Northern forests of Iran.

❖ Overall assessment of the MOAC Tuba Plan

A great part of the participants (74%) believed that this plan failed to reach its goals and objectives as well. The main reason on the expert's opinion is the lack of attention to the ecological as well as socio-economic needs and potentials of the rural society. In many cases, it is used as a new legal way for illegally converting the forests (especially in marginal areas) in order to develop fruit gardens (Akhavan, 2007). Due to their poverty, rural people are looking for loan and banking facilities and the Tuba Plan does provide a business for getting land and money. For example in Arasbaran forests (a part of Caspian Region in Northwest of Iran), loans were given to the not-eligible people who used it for other activities instead of protection and rehabilitation of the degraded areas. A lack of attention to the cultural differences is another weakness. The religious believes of the Kurdish people for instance, prevents them to use bank loans and pay interest rates.

❖ Overall assessment of the public awareness and agricultural training programs in the rural areas

Around 81% of the interviewees believed that the Public Awareness and Training Programs of the government organizations failed to reach their goals and objectives. Interviewees were also asked to suggest the main social target groups for PAP programs. A 23% believed that only the stakeholders of the project area should be involved, while 47% preferred the youth

and women, 26% voted for holy leaders, and 38% for local councils, 43% wanted to focus on NGOs, 25% on local cooperative companies and 40% suggested that all members of the rural society should be able to participate.

❖ Mentioned main reasons for forest loss

The last part of the interview asked the experts to classify what they thought to be the main reasons for forest loss in the mountain forests of the Caspian Region. The result shows that they considered "poverty and lack of environmental awareness among rural society" at the first position, "illegal activities and over-utilization" at second, "destructive traditional cultivation system" at third, "cattle raising in the forests and marginal lands" at forth, "traditional rural living system" at fifth, "lack of an environment-based land use/landscape plan" at sixth, "inappropriate preparation and implementation of the forestry plans" at seventh, "lack of budget and staff for conservation and monitoring" at eighth and "firewood collection and charcoal production" at the ninth position.

5.1.3 Conflict analysis

Based on the interviews with the experts and locals as well as other related studies in the Caspian region, as systematic analysis was executed to structure the complex of the underlying causes and immediate threats to the forests in the Yakhkesh area, which led to the remarkable forest losses. At the same time this analysis intended to identify the necessary and possible interventions that are needed in the form of an integrated ecosystem-based landscape management plan to solve this core problem at its very root (see Figure 29). The analysis revealed the following causes behind, which consequently need urgent observation and countermeasures.

❖ Inadequate management and planning capacities and weak cooperation between Government organizations

The Lack of an integrated management plan for conducting and harmonizing the other planning and management activities of different sector is a main problem towards achieving sustainable development, especially on a local scale. Additionally, the sectoral and hierarchical perspective of each of the responsible organizations and the lack of transdisciplinary knowl-

edge generate manifold overlays, contradictions and conflicts concerning the basic principles and ultimate goals of these plans.

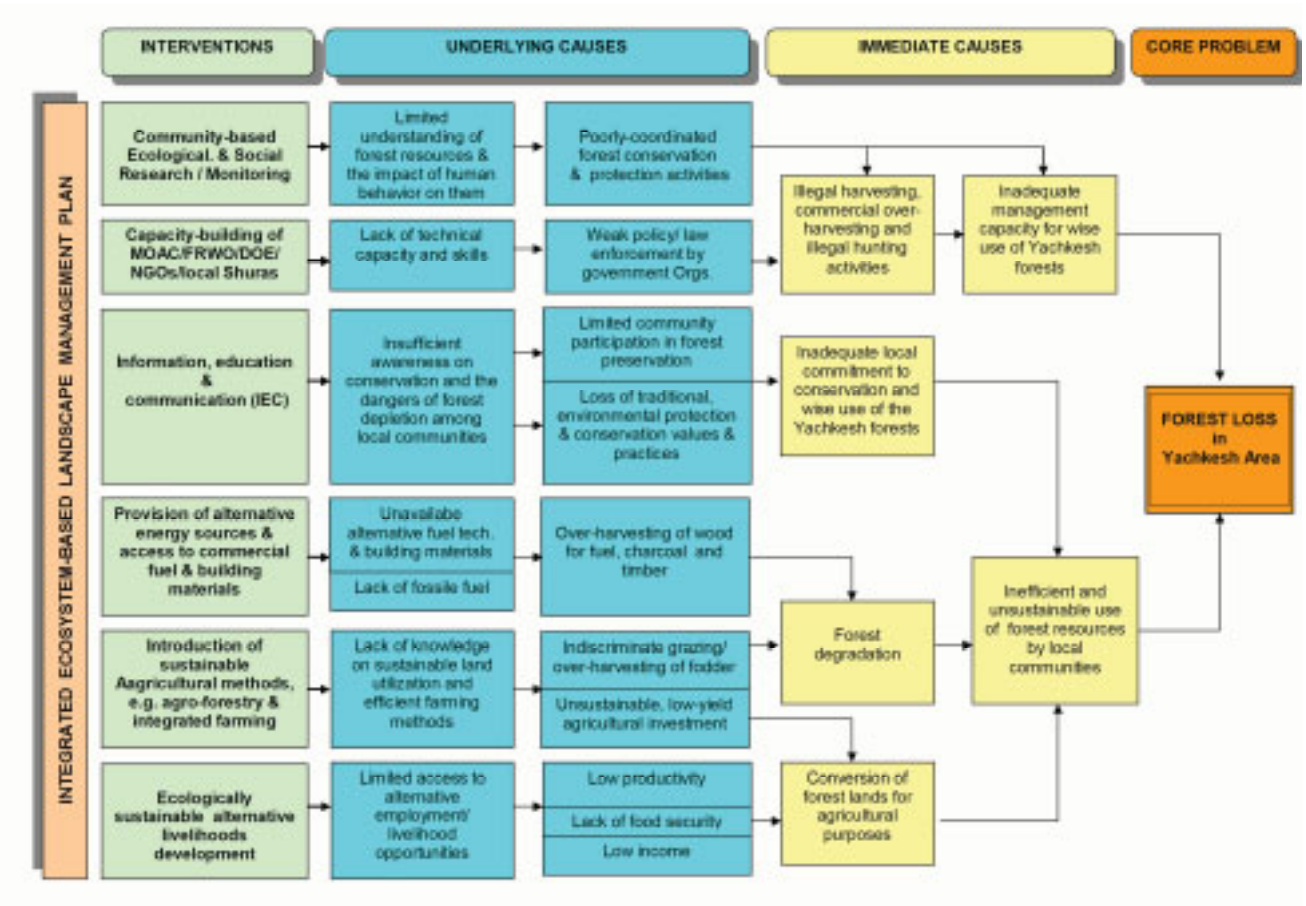


Figure 29: The systematic analysis of the forest loss in the Yakhkesh area and necessary interventions, as a sample for the Caspian Region (Nouri, 2005).

Table 4 shows possible task overlays in more details. Based on this table, FWRO, DoE and MOAC have more overlay tasks and competition than other Governmental organizations. The result is an ineffective and complex top-down planning and management system, which devours a lot of money on both, national and provincial levels, while producing impractical programs, which are barely implemented. This could partly be due to the fact that most of the managers, experts and local staffs of the related government organizations are nonprofessionals concerning the matter of integrated management and planning procedures. Integrative land use planning is a new subject to them who still think in terms of their sectoral planning and management systems.

Dept. /Org.	DC	DL	AB	DPP	FRC	DWS	FWRO	DOE	PG	IMPO	NIOPDC	MRT	MC	MHUD	ME	**SUM**
DC	0	+?	++	++	+	+	++	+	+	+	+?	0	+	0	0	**14**
DL	+?	00	++	++	+	+	++	+	+	+	0	0	+	0	0	**13**
AB	++	++	0	+?	+	++	+	0?	+	+	0	0	+	0	0	**12**
DPP	++	++	++	0	++	++	++	+	+	+	0+	0	+	0	0	**17**
FRC	+	+	+?	++	0	+	+	+	+	+	+	0	++	+	0	**14**
DWS	+	+	++	+	+	0	++	+	+	+	+	+	+	0	+	**14**
FWRO	++	++	+	+	+	+	0	++	+	+	++	+	+	+	+	**18**
DoE	+	+	0?	+	+	+	++	0	+	+	+	+	+	+	+	**14**
PG	+	+	+	+	+	+	+	+	0	+	+	+	+	+	+	**14**
IMPO	+	+	+	+	+	+	+	+	+	0	+	+	+	+	+	**14**
NIOPDC	+	0	0	0	+	+	++	+	+	+	0	+	+	+	+	**12**
MRT	0	0	0	0	0	+?	+	+	+	+	+	0	0	+	+	**8**
MC	+	+	+	+	++	+	+	+	+	+	+	0	0	+	0	**13**
MHUD	0	0	0	0	+	0	+	+	+	+	+	+	+	0	+	**9**
ME	0	0	0	0	0	+	+	+	+	+	+	+	0	+	0	**8**
SUM	**14**	**13**	**13**	**13**	**14**	**14**	**20**	**14**	**14**	**14**	**12**	**8**	**13**	**9**	**8**	

Table 4: Possible task overlays among Governmental organizations[17] on the provincial level

❖ Dominance of destructive and unsustainable land utilization

A rough estimation of the forest areas on the topographic map of 1966 (based on an interpretation of aerial photographs) came to the result that the total area of the dense forest in the project area was around 21.000 ha. The same estimation by means of satellite image from the year 2001 revealed that the dense forests have decreased to approximately 14.100 ha (see Figure 30). Local experts believed that around 3.200 ha of these dense forests, namely the Ghale-dook forests, near Pachat village might still be considered as pristine. The annual rate of forest loss was estimated to range around one percent (0.93%), largely due to land conversion for agricultural purposes, to commercial logging and over harvesting of fuel wood and fodders.

[17] MAC = Ministry of Agricultural crusade (Jahad), DC = Dept. of Cultivation (agriculture), DL = Dept. of livestock affairs, AB = Agricultural bank, DPP = Dept. of propagation and production system, FRC = Organization for rural cooperatives, DWS = Dept. of Water and Soil management, FGWO = Forests, Grass lands and watershed management Organization, DoE = Department of the Environment, PG = Provincial Governor – general, IMPO = Iran management and planning organization, NIOPDC = National Iranian Oil Production and Distribution Company, MRT = Ministry of road and transportation, MC = Ministry of cooperative , MHUD = Ministry of housing and urban development, ME = Ministry of energy (water and power)

The comparison of satellite imagery however showed that the annual rate of forest loss increased to 2.5 % during 1992-2001 (see Figure 30), a period in which 17% of the dense forests have been converted into sparse ones. Even the northern forests of the Mehraban-rood river that are under management plans, around 14% of the dense forests were converted into sparse ones, while the total forest area was not changed.

The main driving forces for this degradation were:

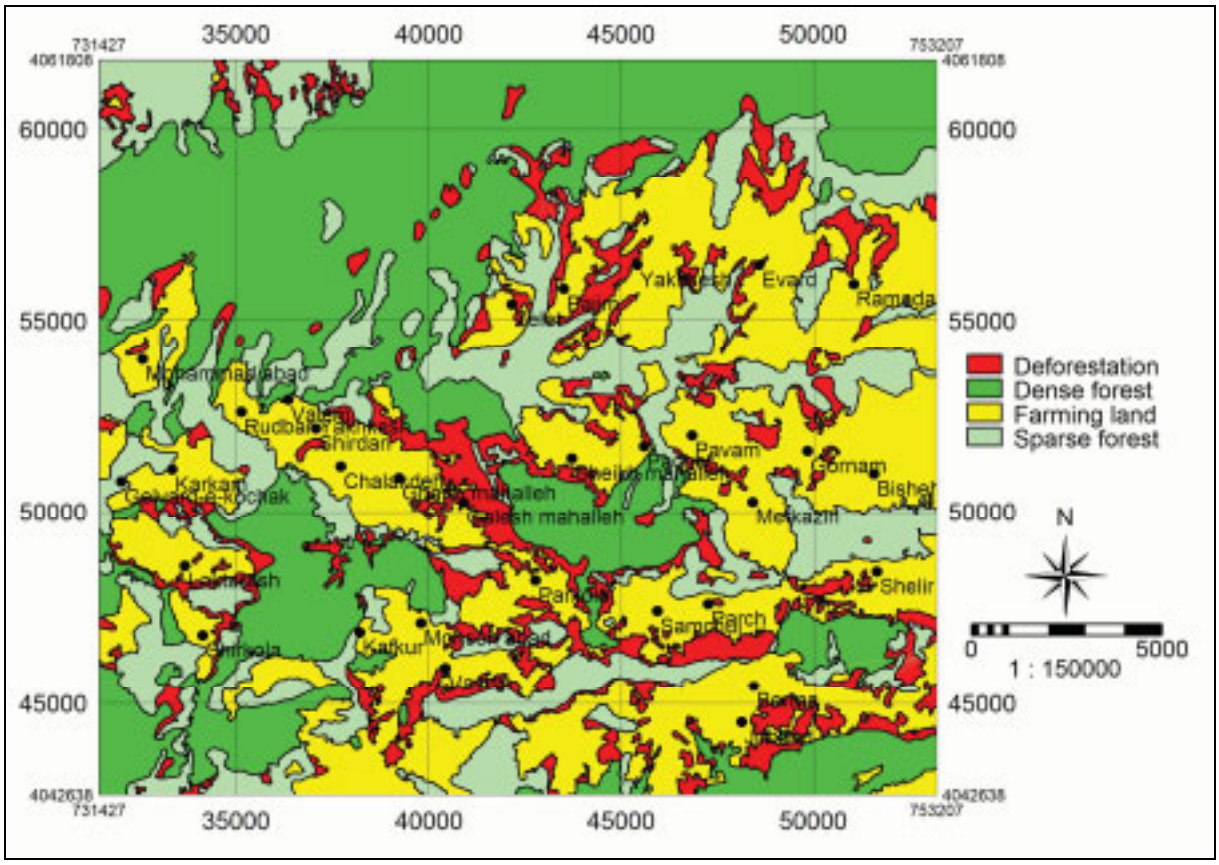
- Conversion of forestlands for agricultural purposes

For centuries, forest areas have been continuously converted to new rain-fed sloppy farmlands (see Picture 17). Due to the natural weakness of the soil, the leaching of nutrients and inefficient cultivation methods, the yield of all major crops is low, i.e. 1100 kg/ha for wheat, 1200 kg/ha for barley, 400 kg/ha for sunflower and 650 kg/ha for soybean. Rather limited natural potentials in company with unsustainable cultivation methods led to a gradual decrease in production. The lack of vegetation cover (during fallowing) and plowing along the slope in such a humid climate, increases run-off, soil erosion and leaching of the nutrients. Thus, villagers have to compensate the low yield with expansion of the farmlands by continuous but hidden conversion of forestlands. All of the local communities, i.e. 1113 families in the Yakhkesh area, but no exogenous groups or commercial enterprises are involved in this process. In spite of severe legal punishments by FWRO, the lack of efficient monitoring and enforcement in the mountain forest areas of Alborz has encouraged this process to be continued.

It is clear that the total demands for new farms and the consequent pressures on the forest areas are different among the villages based on the total population. Among the villages of the area, *Gharib–mahlleh,* and then *Pachat*, *Parkela*, *Parch* and *Samchool*, *Parem* and *Metkazin*, *Valam*, *Roodbar*, *Shirdari*, *Sheikh-mahalleh* and finally *Chalekdeh* have the most adverse effects on their adjacent forests.

- Extensive harvesting of fuel wood from the forests

Fuel wood remains the primary energy source in the project area, primarily due to a lack of access to affordable alternatives (see Picture 18). At present, there is no fuel depot or distribution center in the entire Yakhkesh area and electricity supplies are limited and expensive. Based on the annual per capita consumption of fuel wood for each family (10.13 m^3) and number of families are living in the Yakhkesh area (1113), the total annual consumption of



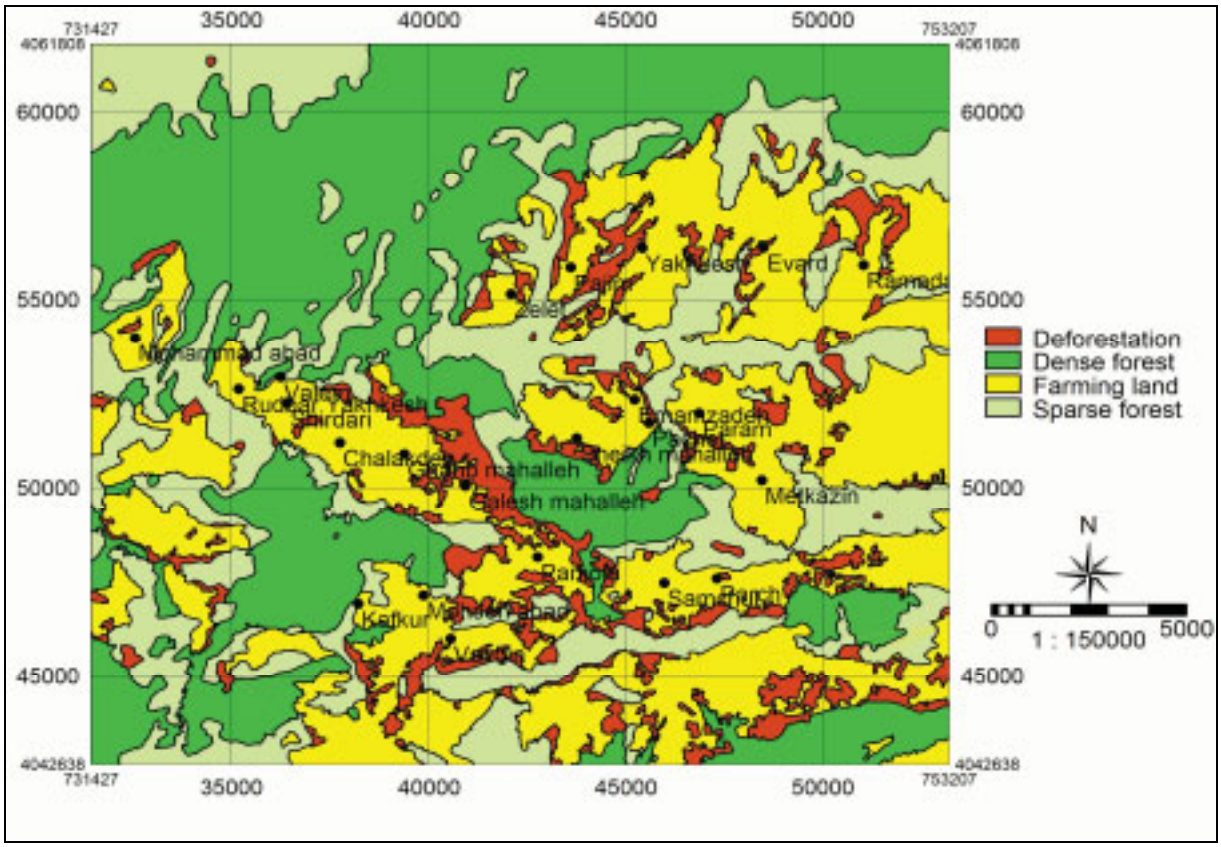


Figure 30: Deforestation between 1966-1992 (above) and 1992-2001 (below) (Nouri, 2005)

fuel wood in the area adds up to around 11275 m³, which means that the local communities are crucially dependent on wood and charcoal. On the other hand, the annual growth of forests in the Yakhkesh area is estimated to lie between 2-3 m³ / ha per year. Consequently, the total consumption of fuel wood for the local populations is equivalent to the annual growth of around 4.510 ha of forests. The use of fuel wood however is highly inefficient, due to poorly ventilated traditional wood-burning stoves and ovens. Energy-efficient wood-burning stoves are not used since the local people have neither access to the relevant technology nor are they aware of such alternatives. Due to the mountainous landscape with cold weather, long distances and access roads that are difficult to pass, the distribution of fossil fuels is very limited across the project area. The lack of fuel stations further increases the fuel costs and most of the villagers cannot afford it. Thus, they prefer to use the traditional warming system of wood-burn stoves and ovens, which is inefficient but free of charge. This activity is implemented all time, but it is highly increased during cold seasons. Again, the pressure of this activity on the forest resources increases by the number of the inhabitants. The main villages involved are *Evard*, *Gharib-mahahlleh*, *Evlar (Yakhkesh)*, and then *Mohammad-Abad*, *Parkela* and *Pajim*.

Recently, a pilot Biogas station was established by UNDP-GEF to support the warming system of a public bath. Due to cattle breeding and agricultural activities in the area, the amount of bio-residuals seems to be enough for the development of such system that might decrease the consumption of fuel-wood for cooking and warming. However, the efficiency of this system during cold seasons is low and needs monitoring.

- Harvesting of the wood for domestic uses (housing, hedging, etc.)

Traditionally, wood has always been the most common material for housing, hedging and other domestic uses across the Caspian Forests (Picture 18). Timber for domestic use is permitted for local communities under the supervision of FRWO, but accurate figures on the per capita use are not available. The results of the previous studies and filed interviews indicate an average of 0.5 m³ per family per year. In conformity with the current population of the project area, another 557 m³ of wood per year must be extracted from the forest areas for domestic use. This is equivalent to the annual growth of 223 ha of forests. Since such timber harvesting is unrestricted and free of charge, over-use is widespread and monitoring or regulation is almost impossible. The consequent pressure of timber extraction for domestic uses did increase by the augmentation of the inhabitants. The main involved villages are again

Evard, Gharib-*mahahlleh*, *Evlar (Yakhkesh),* and then *Mohammad-Abad*, *Parkela* and *Pajim*. This activity is undertaken in all seasons. Since last year, FWRO Mazandaran restricted again the timber harvesting permission, especially for the villages near forest management areas in the northern part, which again intensified the social challenges and illegal activates.

- Livestock grazing in the forest and in other marginal areas

Villagers in the project area rear cattle, sheep and goats as a complementary source of income. The total need for fodder in the Yakhkesh area is estimated to be around 35.000 tons per year. The total production of fodder from the agricultural by-products and other sources however is only around 10.500 tons. Thus, the remaining 24.500 tons must be provided from vegetation covers of forests and marginal lands. Livestock grazing on shrubbery and tree shoots in forest areas has marked negative impacts on the natural regeneration of tree species. Cattlemen also cut trees and shrubs illegally to create open spaces in which the ground cover of herbaceous plants quickly develops and forms new pastures for livestock in dense forest areas. They also cut trees and shrubs' foliage to use it as fodder in the winter. This activity causes irreversible damages to the trees by destructing the canopy, decreasing photosynthesis and growth, and spreading diseases, especially fungi. Currently, FWRO promote cattlemen to exit their livestock from the managed forests. Nevertheless, these plans often face financial problems, while shifting the grazing pressure to the unmanaged areas. The grazing pressure and its consequent negative impacts on the forests in *Pachat*, *Pajim* and *Zelet*, *Evlar -Yakhkesh*, *Shekh-mahalleh*, *Gharib-mahalleh* and *Parkela* villages are higher than elsewear. This activity starts from the beginning of spring up to the mid of autumn.

- Illegal commercial logging and hunting

Within the Yakhkesh area, invaluable old stands of trees and shrubs, especially Beech, Yew, Box tree, Oak, Siberian Elm, Elm, Maple, Service tree, Wild cherry, etc. are still to be found. They are rather attractive for both, indigenous and exogenous wood-smugglers, especially in those areas where the monitoring and conservation levels are weak. There is no reliable data on the number of people involved but it is clear that timber is illegally harvested and transported to the major cities of *Mazandaran* province like *Behshahr*, *Neka*, *Galoogah*, *Tirtash* and also adjacent areas, especially *Damghan* and *Semnan* (in *Semnan Province).* Licensed logging is carried out only in the northern parts of the Mehraban-rood River (Picture 19).

Picture 17: Forest conversion to farmland

Picture 18: Wood plays the dominant role for heating, cooking and public bath (Firewood) or as construction material for housing and hedging (Nouri, 2005-7)

Picture 19: Illegal logging by wood smugglers threatened the old stands in unprotected areas

Currently, logging concessions have been licensed in the north with a permitted logging coupe of 2-3 m^3 per ha. These harvest levels are regularly exceeded and unsustainable logging practices such as careless felling and a widespread cutting of logging tracks has resulted in heavy damages to the forest cover in the logged area.

On the other hand, over-extraction of timber and the use of external working forces in most of the logging concession areas, force the local people to compete with private companies in the over-harvesting of the forest resources. Our field studies and the UNDP/GEF project show that around 2.800 m^3 of timber (20-30% for fuel–wood) is illegally extracted from the forests per year. This is equivalent to the annual growth potential of 1.128 ha. As this destructive activity aims mostly at desirable species such as Beech, Yew, Box tree, Siberian-elm, Service tree, Wild cherry, etc., the quality of the forest ecosystems decreases more than their quantity, causing a remarkable loss of biodiversity.

The logging activities and the degradation of the adjacent forest ecosystems increased the importance of the southern Mehraban-rood river forests as a refuge for threatened wildlife species. Besides illegal hunting, licensed hunting is also carried out in the Yakhkesh forests. Hunters include local people with out–of–date arms as well as hunters from outside with modern automatic guns. The total number of the local hunters is estimated to be around 100 persons (around 5 hunters in each village) but no such estimation is available for exogenous hunters, who come from the adjacent areas, especially from *Gallugah*, *Behshahr*, *Neka*, *Tirtash*, *Semnan* and *Dameghan*. Due to the weak enforcement and monitoring, hunters regularly bag more than is officially permitted by DoE. Among the major species that are hunted, red deer, buck (roe deer), bears, leopards, wild boar and birds such as ringdove, wood pigeon, quail, partridge and pheasant must be mentioned. Animals are hunted for food, sport and to reduce damages to livestock and crops (in the case of bears, wild boar, badgers, wolf and leopard). An approximate estimation by DoE staffs and local experts shows that around 20 heads of red and roe deer, 1000 pieces of pheasant and 500 pieces of partridge are hunted annually in the project area.

❖ Poverty and lack of awareness and knowledge about environmentally sound economic alternatives for proper utilization of the land resources

From the historical documents, human settlement in the Yakhkesh area date back to around 1000 years ago. Since then, and likewise in other forest areas across the Alborz Mountains, traditional living system - mainly depending on the forests - remained unchanged. That is why

the income derived from farming and cattle-raising often hovers at or below the subsistence level. During the last decades, government organizations have focused more on the development and strengthening of the infrastructures than on the improvement of the traditional land use system. Thus, a lack of awareness about the importance of the natural resources, of effective agricultural techniques, and of economic and environmentally sound alternative livelihoods should be referred as the main underlying causes for compulsory conversion of the forestlands. This lack of awareness and advice even led to the misuse of new technologies like agricultural machineries, chemical fertilizers or pesticides, which did not only fail to increase the production capacity, but also accelerated the destruction and degradation rate of the natural resources. For instance, the increasing number of tractors after the Islamic revolution led to a huge illegal conversion of the forests and rangelands in the entire upstream areas of the Caspian region (Nouri, 1999).

5.2 Ecological assessment using the Iranian approach

The regional ecological suitability assessment for agricultural activities in 7 suitability classes and forestry and afforestation in 7 classes according to the presented assessment models of Iran (scale 1: 25000; procedure: see chapter II) and based on the generally available data resulted in the following issues:

5.2.1 Ecological assessment of the arable lands for agricultural activities

Table 5 shows the data layers, which were used for executing the agricultural suitability assessment, namely slope degree and soil depth. Both indicators always played the main roles (rather than soil texture or climate) in selection of the suitable lands for cultivation, especially dry-farming in the mountain areas of the Caspian Region (MOAC, Mazandaran 2002).

Table 5: Indicators for developing the agricultural assessment (* = suitability classes for the single indicators)

Class*	Slope (Inclination) (%)	Soil depth
1	0 - 2.0	Deep (100 -120 cm & more)
2	2.1 - 5.0	Semi-deep to deep (80 to 100 cm)
3	5.1 – 8.0	Semi-deep (50 to 80 cm)
4	8.1 – 12.0	Shallow (less than 50 cm)
5	12.1 – 15.0	---
6	15.1 – 30.0	---
7	30.1 – 65.0	---
8	> 65.0	---

According to Makhdoum (2002), slope class 1 to 3 are more capable for irrigated farming, class 4 for dry-farming, fodder cultivation or orchard development, class 5 for fodder cultivation, grassland or for orchard, and class 6 might be used for orchard or wood cultivation by considering necessary measures against soil erosion. The seventh class of the model just shows none suitable areas, with a slope degree more than 30 percent.

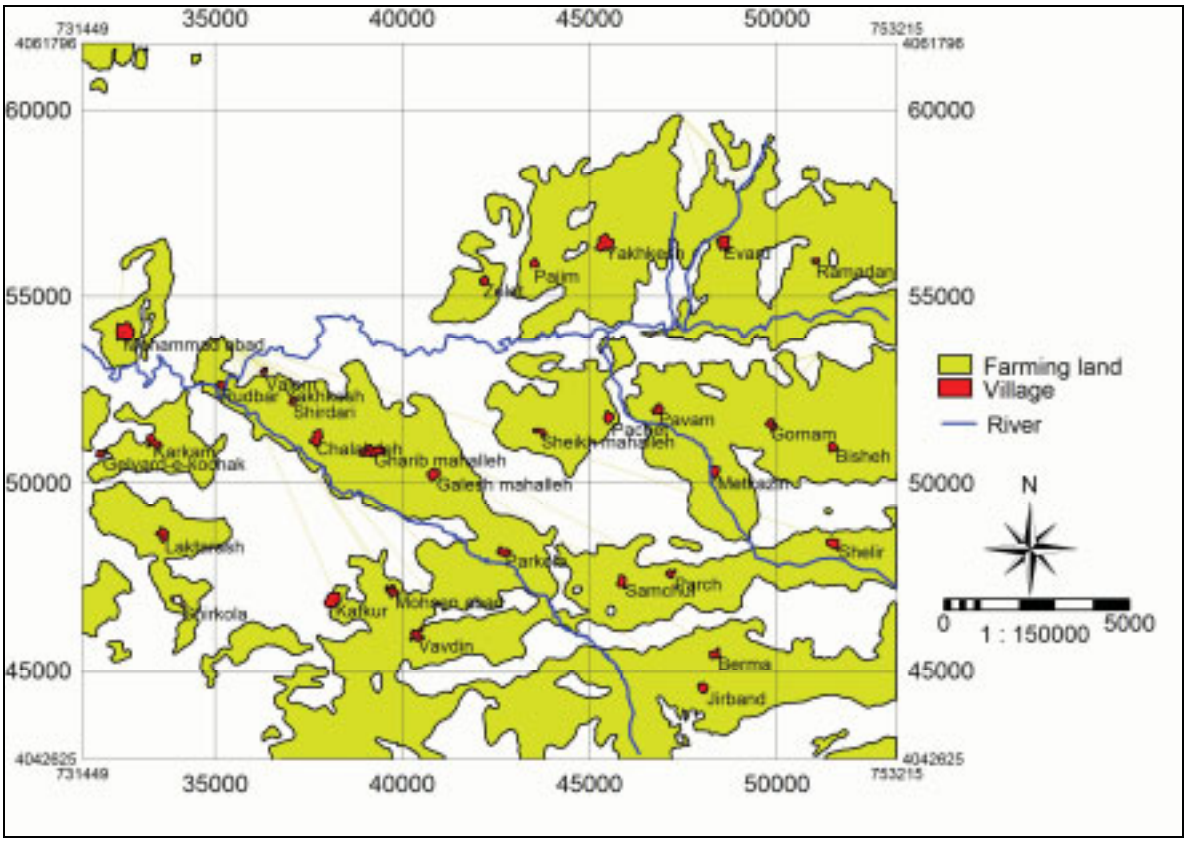


Figure 31: Current arable land on the land use map (2001)

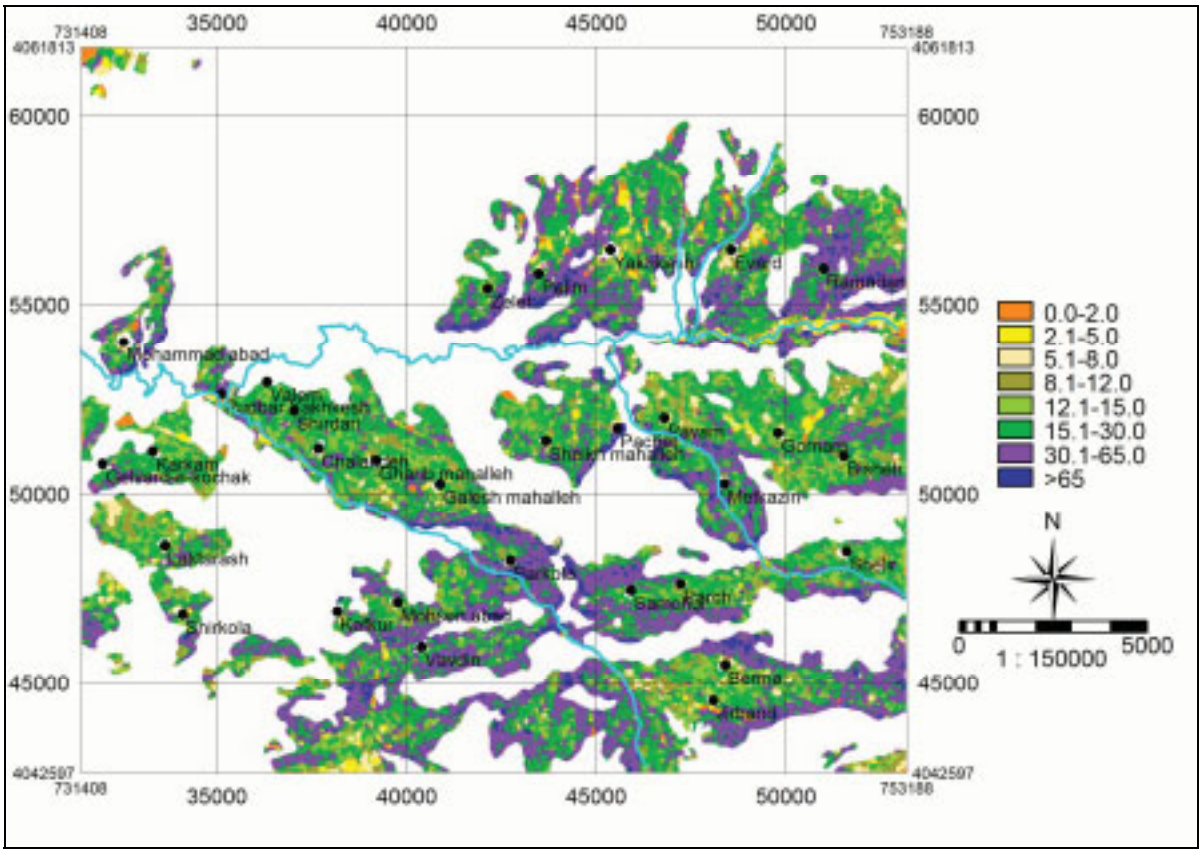
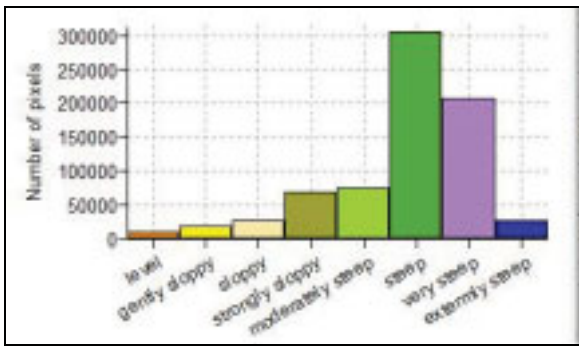


Figure 32: Slope degree of the current arable land, following Table 5

A quick look at the cross section of the slope degree map (see Figure 16 / chapter IV.1) and the current cultivated area in the land use map (Figure 31), reveals that the major part of the current farmlands have only poor ecologic potential for cultivation (see Figure 32). Histogram 10 shows the respective area estimation. It is clear that around 73% of the cultivated areas are steep to extremely steep, with high potential concerning soil erosion. Actually, only 7.4% has suitable slope degree for cultivation.



	npix	npixpct	potnotund	Area
level	9867	0.53	1.33	2220075
gently sloppy	18317	0.98	2.48	4121325
sloppy	26956	1.45	3.64	6065100
strongly sloppy	69122	3.71	9.34	15552450
moderately steep	75640	4.06	10.22	17019000
steep	306525	16.44	41.43	68965800
very steep	206377	11.07	27.89	46434825
extermly steep	27119	1.45	3.67	6101775
Avg	92491	4.96	12.50	20810419
StD	107244	5.75	14.49	24129876
Sum	739926	39.69	100.00	166483350

Histogram 11: Area estimation for the suitability of current arable land according to slope degree

The different soil depth classes from shallow (1) to deep (IV) may further constrict the suitability. Table 6 shows the overall suitability classes I - VII when both slope degree and soil depth are considered

Table 6: Agricultural suitability assessment [18]

Suitability classes	Slope degree (%)	Soil depth
II	0-2	shallow
II	0-2	semi-deep
I	0-2	semi-deep to deep
I	0-2	deep
II	2.1 - 5	shallow
II	2.1 - 5	semi-deep
I	2.1 - 5	semi-deep to deep
I	2.1 - 5	deep
III	5.1 - 8	shallow
III	5.1 - 8	semi-deep
II	5.1 - 8	semi-deep to deep

[18] Suitability classes:
I-III: irrigated farming, IV: dry-farming, fodder cultivation or orchard development; V: fodder cultivation, grassland or for orchard: VI: rather limited farmland suitability: orchard or wood cultivation by considering necessary measures against soil erosion; VII: no kind of farmland suitable (slope degree more than 30 percent.)

Suitability classes	Slope degree (%)	Soil depth
II	5.1 - 8	deep
IV	8.1 - 12	shallow
IV	8.1 - 12	semi-deep
IV	8.1 - 12	semi-deep to deep
IV	8.1 - 12	deep
V	12.1 - 15	shallow
V	12.1 - 15	semi-deep
IV	12.1 - 15	semi-deep to deep
IV	12.1 - 15	deep
VI	15.1 - 30	shallow
VI	15.1 - 30	semi-deep
VI	15.1 - 30	semi-deep to deep
VI	15.1 - 30	deep
VII	30.1 - 65	shallow
VII	30.1 - 65	semi-deep
VII	30.1 - 65	semi-deep to deep
VII	30.1 - 65	deep
VII	> 65	shallow
VII	> 65	semi-deep
VII	> 65	semi-deep to deep
VII	> 65	deep

The map of the current arable land (Figure 31) was then crossed again with both, slope degree and soil depth in a raster format to finalize the suitability assessment. The results are shown as Figure 33 with the area estimation in the Histogram 12. The map illustrates that 32% of the current farmlands (around 5.343 ha) are not at all qualified for agricultural activities. Special measures, e.g. establishment of the nursery covers and afforestation should be considered for soil and water conservation. Another 43% (around 7.347 ha) of the cultivated land just reaches the sixth suitability class, which still could be used for the establishment of the wood plantations or fruit orchards in order to prevent soil erosion.

The current rain fed or irrigated cultivations, however, could be continued on 8.5% (1.436 ha) of the arable lands with first, second and third suitability classes. Only dry farming with proper utilization of the fertilizers and sustainable ploughing methods is appropriate for around 16,5% (2.776 ha) of the farmlands with fourth capability class, but these areas plus

another 105 ha of class 5 might also be assigned for cultivation of the fodder crops (especially alfalfa) or combined with fruit orchards as agro-forestry systems.

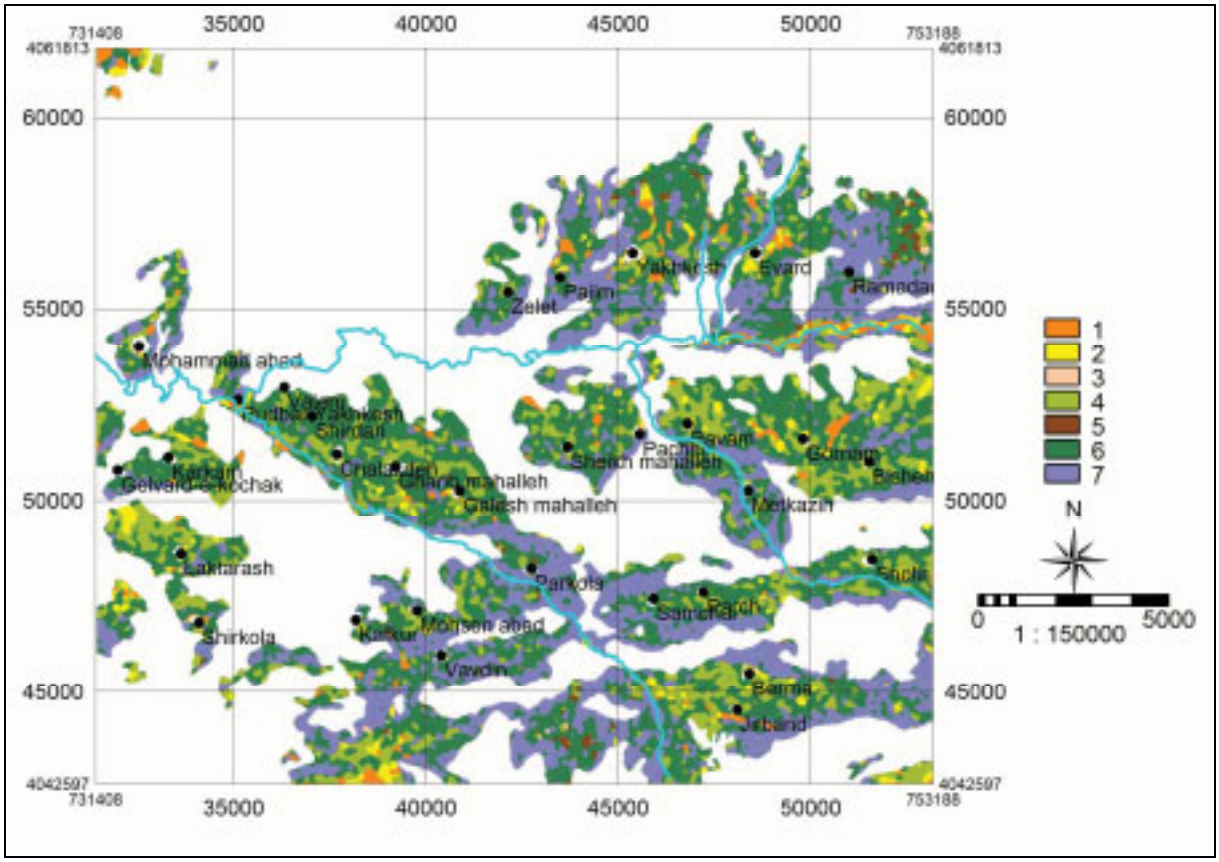
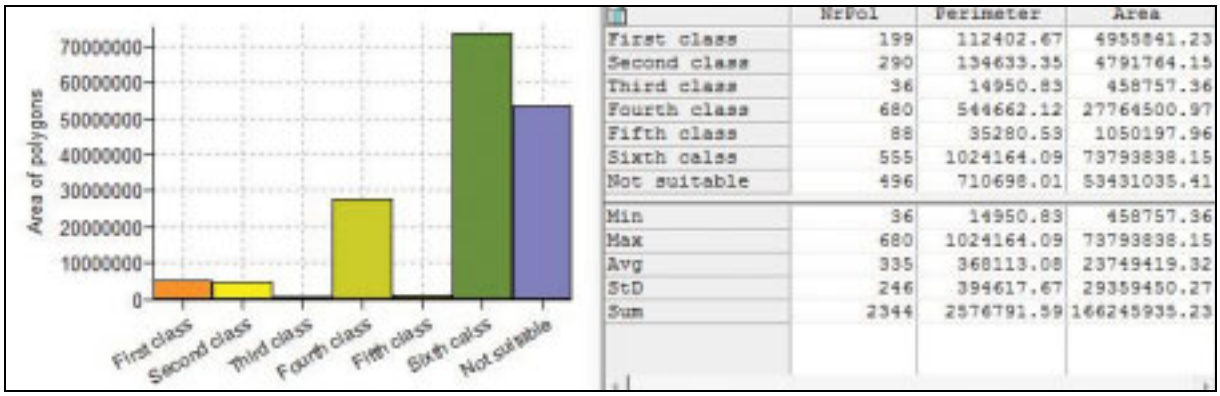


Figure 33: Suitability of the current arable land according to slope degree and soil depth (according to Table 6)

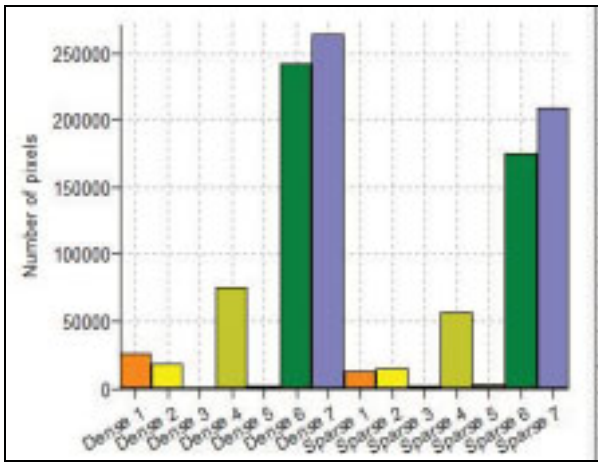


	NrPol	Perimeter	Area
First class	199	112402.67	4955841.23
Second class	290	134633.35	4791764.15
Third class	36	14950.83	458757.36
Fourth class	680	544662.12	27764500.97
Fifth class	88	35280.53	1050197.96
Sixth calss	555	1024164.09	73793838.15
Not suitable	496	710698.01	53431035.41
Min	36	14950.83	458757.36
Max	680	1024164.09	73793838.15
Avg	335	368113.08	23749419.32
StD	246	394617.67	29359450.27
Sum	2344	2576791.59	166245935.23

Histogram 12: Area estimation for the suitability of current arable land, based on the slope degree and soil depth and according to Table 6

This could also support the semi-extensive animal husbandry, while increasing the soil fertility and preventing soil erosion. A rough estimation of the cultivated areas by MOAC-Mazandaran shows that in 2001, around 67% of the arable lands were assigned for dry-farming of wheat, barely, sunflower and soybean, while 20% were fallow lands (weak soil fertility). Around 6% were identified as orchards and the rest (7%) were under irrigated cultivation (potato, rice and vegetables). This shows again that planning alternatives should focus on dry-farming and fallowed areas, while access to the surface water is limited due to the high inclination of the arable lands and the small area, which is ecologically-suitable for irrigated farming has been already under cultivation.

To show the competition among agriculture and forestry, the agricultural suitability assessment was also done for the current forest areas. Figure 34 shows the assessment results and the respective area estimation is given in Histogram 13. The results indicate that around 1665 ha (around 7%) of the current sparse and dense forests are ecologically suitable (class I to III) for agricultural activities, while the other 2956 ha (around 12%) have medium (class IV) or lower (class V & VI, 10033 ha, around 40%) suitability and the rest (10089 ha, around 41%) are not suitable for such activities. However, the risk of forest conversion for agriculture seems much higher for the sparse forests than for the dense forests, especially in the vicinity of the farmlands (See Figure 35)



	npix	npixpct	pctnotund	Area
Dense 1	25241	1.35	2.30	5679225
Dense 2	18378	0.99	1.67	4135050
Dense 3	932	0.05	0.08	209700
Dense 4	75307	4.04	6.85	16944075
Dense 5	2011	0.11	0.18	452475
Dense 6	241652	12.96	21.97	54371700
Dense 7	264169	14.17	24.02	59438025
Sparse 1	13054	0.70	1.19	2937150
Sparse 2	14426	0.77	1.31	3245850
Sparse 3	1968	0.11	0.18	442800
Sparse 4	56081	3.01	5.10	12618225
Sparse 5	2709	0.15	0.25	609525
Sparse 6	175167	9.40	15.93	39412575
Sparse 7	208581	11.19	18.97	46930725
Min	932	0.05	0.08	209700
StD	98519	5.28	8.96	22166828
Sum	1099676	59.00	100.00	247427100

Histogram 13: Area estimation for agricultural suitability classes within the forest areas

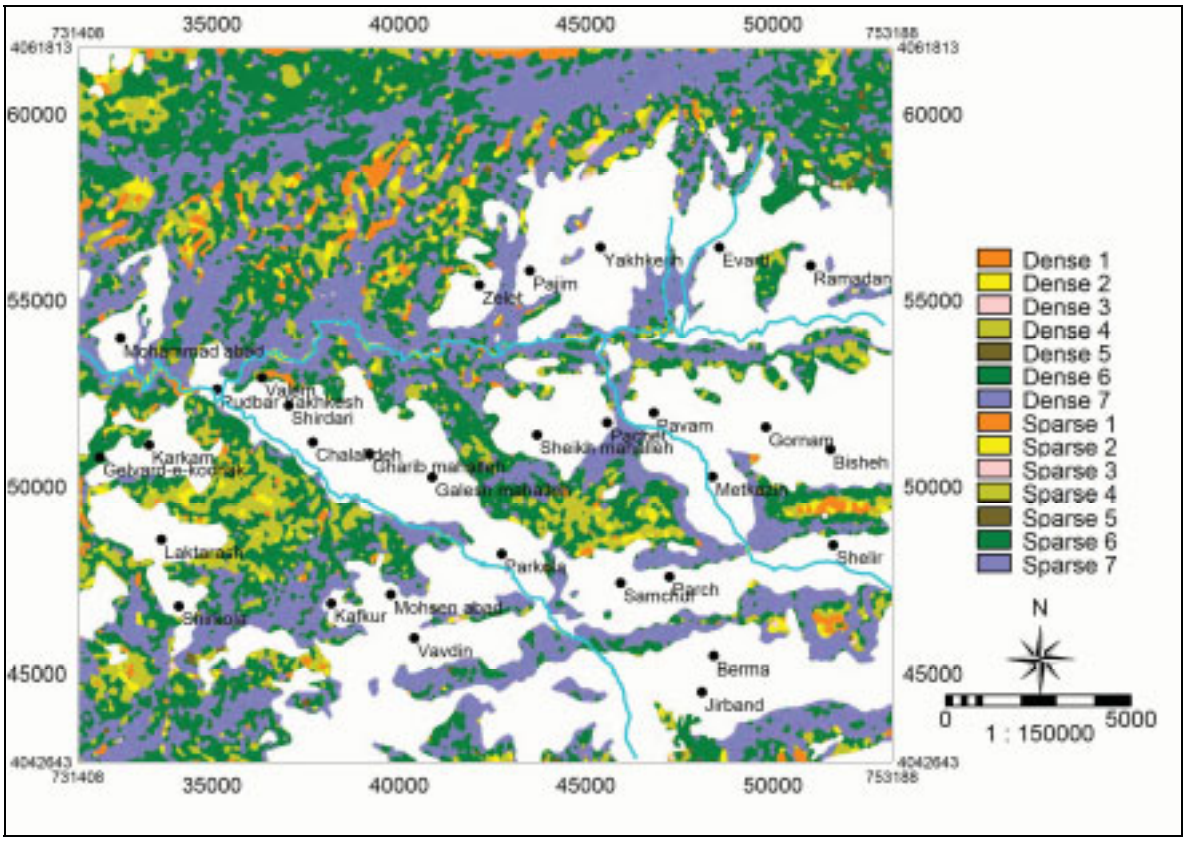


Figure 34: Ecological suitability of the forest areas for agricultural activities

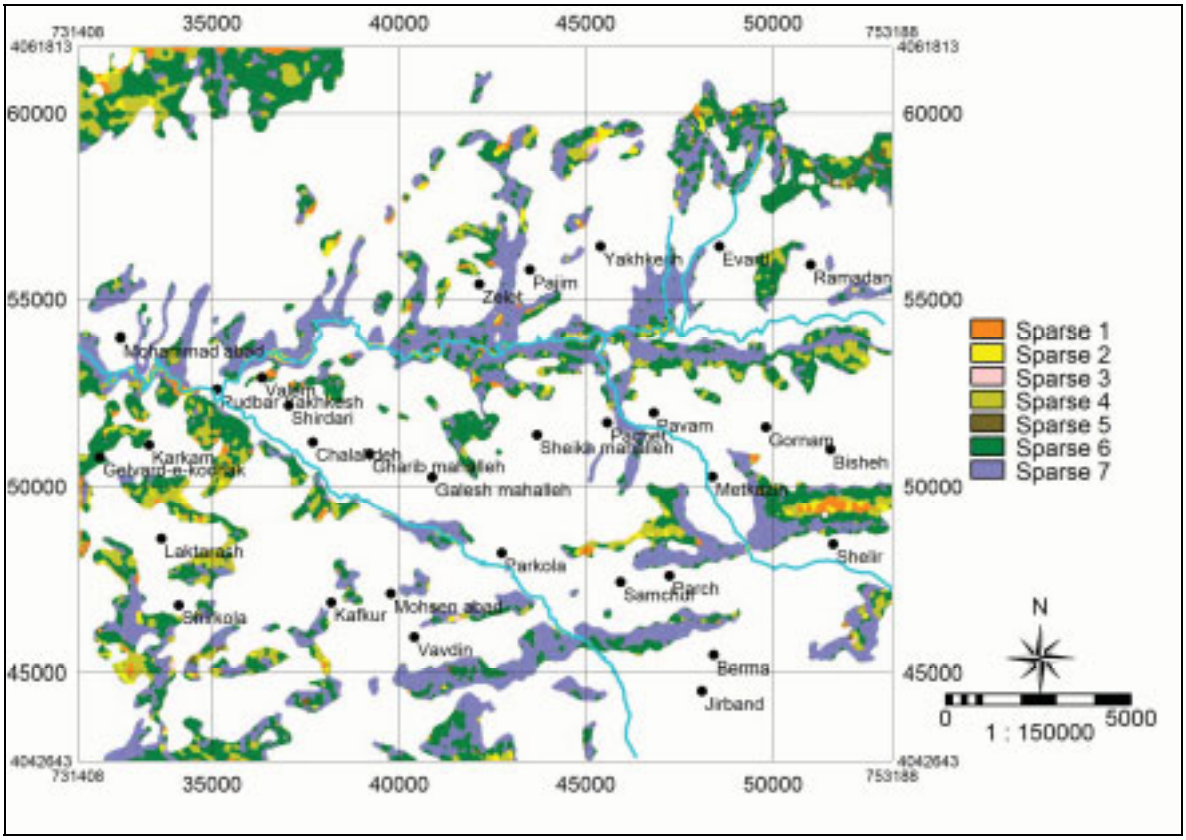


Figure 35: Ecological suitability of the sparse forests for agricultural activities

5.2.2 Ecological assessment for forestry and afforestation

Table 7 shows the data layers, which were used for executing the forestry and afforestation suitability assessment. The suitability assessment is based on slope degree, altitude range for the main forest communities in the Caspian region, soil depth and soil texture as presented in Table 8. According to Makhdoum (2002), the classes I-III have only limited restrictions for industrial forest management, only the suitability degree decreases by increase of the slope degree. This is why the same color (dark green) has been chosen in the map for all three suitability classes. Class IV has medium suitability for timber extraction, but is usually assigned for afforestation if farming is established on the site. In addition to the low vegetation density (under 50%, normally from 10 to 30%), classes V-VII have inadequate ecological conditions and thus minor importance for timber extraction. According to the local conditions they are usually assigned for soil, water or wildlife habitat conservation.

Table 7: Data layers for developing the forestry and afforestation assessment

Class*	Slope degree (%)	Altitude range (m)	Soil depth	Soil texture
1	0.0 – 25.0	0-1000	Deep (100 -120 cm & more)	Heavy
2	25.1 - 35.0	1001-1400	Semi-deep to deep (80 to 100 cm)	Semi-heavy
3	35.1 – 45.0	1401-1800	Semi-deep (50 to 80 cm)	Moderate to semi-heavy
4	45.1 – 55.0	1801-2600	Shallow (less than 50 cm)	Moderate
5	55.1 – 65.0	---	---	---
6	65.1 – 75.0	---	---	---
7	> 75.0	---	---	---

Unlike the agricultural suitability assessment that has been restricted to the respective areas, the forestry and afforestation assessment was realized for the entire study area in order to investigate the potential ecological suitability for forestry and nature conservation, even across the current arable lands that have been mostly developed through conversion of the forests. This shows again the competition among agriculture and forestry and is especially important to delineate those farmlands, which have been already fallowed due to the weak soil fertility,

but could still be used for environmentally-sound alternatives e.g. Agro-forestry or even re-forestation. In order to gain a more realistic view, the process was also executed for the current forest areas. For this purpose, the raster maps of elevation and slope degree were crossed at first, then the result map was crossed with the soil depth (Figure 24) and finally this result map was crossed with the soil texture map.

Table 8: Forestry and afforestation suitability assessment model[19]

Suitability class	Altitude class (m)	Slope degree (%)	soil depth	soil texture
I	0-1000	0-25	Deep	Heavy
I	0-1000	0-25	Deep	moderate to semi-heavy
II	0-1000	34-45	Deep	Heavy
II	0-1000	34-45	Deep	moderate to semi-heavy
II	0-1000	25-35	Deep	Heavy
II	0-1000	25-35	Deep	moderate to semi-heavy
I	0-1000	0-25	Semi-deep to deep	semi-heavy
III	1000-1400	0-25	Semi-deep to deep	semi-heavy
II	0-1000	25-35	Semi-deep to deep	semi-heavy
IV	0-1000	45-55	Deep	Heavy
IV	0-1000	45-55	Deep	moderate to semi-heavy
VII	0-1000	> 75	Semi-deep to deep	semi-heavy
VII	1000-1400	> 75	Semi-deep to deep	semi-heavy
IV	1000-1400	45-55	Semi-deep to deep	semi-heavy
III	1000-1400	25-35	Semi-deep to deep	semi-heavy
III	1000-1400	34-45	Semi-deep to deep	semi-heavy
VI	1000-1400	65-75	Semi-deep to deep	semi-heavy
VII	0-1000	> 75	Deep	Heavy
VII	0-1000	> 75	Deep	moderate to semi-heavy
VI	0-1000	65-75	Semi-deep to deep	semi-heavy
IV	0-1000	55-65	Deep	Heavy
IV	0-1000	55-65	Deep	moderate to semi-heavy
III	0-1000	34-45	Semi-deep to deep	semi-heavy
VI	0-1000	65-75	Deep	Heavy
VI	0-1000	65-75	Deep	moderate to semi-heavy

[19] suitability classes: I-III: industrial forest management with decreasing suitability degree depending on the slope degree; IV: medium suitability for timber extraction; farmland is usually assigned for afforestation; V-VII: soil, water or wildlife habitat conservation due to inadequate ecological conditions and thus minor importance for timber extraction

Suitability class	Altitude class (m)	Slope degree (%)	soil depth	soil texture
IV	0-1000	45-55	Semi-deep to deep	semi-heavy
V	0-1000	55-65	Semi-deep to deep	semi-heavy
V	1000-1400	55-65	Semi-deep to deep	semi-heavy
III	1000-1400	0-25	Deep	Heavy
III	1000-1400	0-25	Deep	moderate to semi-heavy
III	1000-1400	25-35	Deep	Heavy
III	1000-1400	25-35	Deep	moderate to semi-heavy
III	1000-1400	34-45	Deep	Heavy
III	1000-1400	34-45	Deep	moderate to semi-heavy
IV	1400-1800	45-55	Semi-deep to deep	semi-heavy
III	1400-1800	25-35	Semi-deep to deep	semi-heavy
IV	1000-1400	55-65	Deep	Heavy
IV	1000-1400	55-65	Deep	moderate to semi-heavy
V	1400-1800	65-75	Semi-deep to deep	semi-heavy
IV	1400-1800	0-25	Semi-deep to deep	semi-heavy
V	1400-1800	55-65	Semi-deep to deep	semi-heavy
IV	1400-1800	25-35	Deep	Heavy
IV	1400-1800	25-35	Deep	moderate to semi-heavy
IV	1400-1800	34-45	Deep	Heavy
IV	1400-1800	34-45	Deep	moderate to semi-heavy
IV	1400-1800	34-45	Semi-deep	semi-heavy
IV	1400-1800	0-25	Deep	Heavy
IV	1400-1800	0-25	Deep	moderate to semi-heavy
V	1400-1800	65-75	Deep	Heavy
V	1400-1800	65-75	Deep	moderate to semi-heavy
III	1000-1400	25-35	Semi-Deep	semi-heavy
III	1000-1400	25-35	Semi-Deep	moderate
III	1000-1400	0-25	Semi-Deep	semi-heavy
III	1000-1400	0-25	Semi-Deep	moderate
III	1000-1400	34-45	Semi-Deep	semi-heavy
III	1000-1400	34-45	Semi-Deep	moderate
IV	1400-1800	45-55	Deep	Heavy
IV	1400-1800	45-55	Deep	moderate to semi-heavy
IV	1000-1400	45-55	Deep	Heavy
IV	1000-1400	45-55	Deep	moderate to semi-heavy
VII	1400-1800	> 75	Deep	Heavy
VII	1400-1800	> 75	Deep	moderate to semi-heavy

Suitability class	Altitude class (m)	Slope degree (%)	soil depth	soil texture
III	1400-1800	0-25	Semi-Deep	semi-heavy
III	1400-1800	0-25	Semi-Deep	moderate
IV	1000-1400	45-55	Semi-Deep	semi-heavy
IV	1000-1400	45-55	Semi-Deep	moderate
V	1400-1800	45-55	Semi-Deep	semi-heavy
V	1400-1800	45-55	Semi-Deep	moderate
III	1400-1800	25-35	Semi-Deep	semi-heavy
III	1400-1800	25-35	Semi-Deep	moderate
IV	1400-1800	34-45	Semi-Deep	semi-heavy
IV	1400-1800	34-45	Semi-Deep	moderate
VII	1400-1800	> 75	Semi-Deep	semi-heavy
VII	1400-1800	> 75	Semi-Deep	moderate
VII	1400-1800	> 75	Semi-deep to deep	semi-heavy
VII	1000-1400	> 75	Deep	Heavy
VII	1000-1400	> 75	Deep	moderate to semi-heavy
V	1400-1800	55-65	Semi-Deep	semi-heavy
V	1400-1800	55-65	Semi-Deep	moderate
VI	1000-1400	65-75	Semi-Deep	semi-heavy
VI	1000-1400	65-75	Semi-Deep	moderate
V	1400-1800	55-65	Deep	Heavy
V	1400-1800	55-65	Deep	moderate to semi-heavy
IV	1400-1800	0-25	Shallow	semi-heavy
IV	1400-1800	0-25	Shallow	moderate to semi-heavy
IV	1400-1800	25-35	Shallow	semi-heavy
IV	1400-1800	25-35	Shallow	moderate to semi-heavy
IV	1400-1800	45-55	Shallow	semi-heavy
IV	1400-1800	45-55	Shallow	moderate to semi-heavy
IV	1400-1800	34-45	Shallow	semi-heavy
IV	1400-1800	34-45	Shallow	moderate to semi-heavy
VI	1000-1400	65-75	Deep	Heavy
VI	1000-1400	65-75	Deep	moderate to semi-heavy
III	1000-1400	45-55	Shallow	semi-heavy
III	1000-1400	45-55	Shallow	moderate to semi-heavy
III	1000-1400	25-35	Shallow	semi-heavy
III	1000-1400	25-35	Shallow	moderate to semi-heavy
VI	1400-1800	65-75	Semi-Deep	semi-heavy
VI	1400-1800	65-75	Semi-Deep	moderate

Suitability class	Altitude class (m)	Slope class (%)	soil depth	soil texture
III	1000-1400	34-45	Shallow	semi-heavy
III	1000-1400	34-45	Shallow	moderate to semi-heavy
II	1000-1400	0-25	Shallow	semi-heavy
II	1000-1400	0-25	Shallow	moderate to semi-heavy
IV	1000-1400	55-65	Semi-Deep	semi-heavy
VI	1000-1400	55-65	Semi-Deep	moderate
VI	1000-1400	65-75	Shallow	semi-heavy
VI	1000-1400	65-75	Shallow	moderate to semi-heavy
VI	1400-1800	65-75	Shallow	semi-heavy
VI	1400-1800	65-75	Shallow	moderate to semi-heavy
V	1000-1400	55-65	Shallow	semi-heavy
V	1000-1400	55-65	Shallow	moderate to semi-heavy
VII	1000-1400	> 75	Shallow	semi-heavy
VII	1000-1400	> 75	Shallow	moderate to semi-heavy
II	0-1000	25-35	Shallow	semi-heavy
II	0-1000	25-35	Shallow	moderate to semi-heavy
I	0-1000	0-25	Shallow	semi-heavy
I	0-1000	0-25	Shallow	moderate to semi-heavy
III	0-1000	45-55	Shallow	semi-heavy
III	0-1000	45-55	Shallow	moderate to semi-heavy
VII	1000-1400	> 75	Semi-Deep	semi-heavy
VII	1000-1400	> 75	Semi-Deep	moderate
III	0-1000	34-45	Shallow	semi-heavy
III	0-1000	34-45	Shallow	moderate to semi-heavy
VI	0-1000	65-75	Shallow	semi-heavy
VI	0-1000	65-75	Shallow	moderate to semi-heavy
VII	0-1000	> 75	Shallow	semi-heavy
VII	0-1000	> 75	Shallow	moderate to semi-heavy
V	0-1000	55-65	Shallow	semi-heavy
V	0-1000	55-65	Shallow	moderate to semi-heavy
III	1000-1400	0-25	Shallow	semi-heavy
V	1400-1800	55-65	Shallow	semi-heavy
VII	1400-1800	> 75	Shallow	semi-heavy
VII	0-1000	> 75	Semi-Deep	semi-heavy
VII	0-1000	> 75	Semi-Deep	moderate
III	0-1000	34-45	Semi-Deep	semi-heavy
III	0-1000	34-45	Semi-Deep	moderate

Suitability class	Altitude class (m)	Slope degree (%)	Soil depth	Soil texture
III	0-1000	45-55	Semi-Deep	semi-heavy
III	0-1000	45-55	Semi-Deep	moderate
VI	0-1000	65-75	Semi-Deep	semi-heavy
VI	0-1000	65-75	Semi-Deep	moderate
I	0-1000	0-25	Semi-Deep	semi-heavy
I	0-1000	0-25	Semi-Deep	moderate
IV	0-1000	55-65	Semi-Deep	semi-heavy
IV	0-1000	55-65	Semi-Deep	moderate
II	0-1000	25-35	Semi-Deep	semi-heavy
II	0-1000	25-35	Semi-Deep	moderate
V	1800-2600	0-25	Deep	Heavy
V	1800-2600	0-25	Deep	moderate to semi-heavy
V	1800-2600	25-35	Deep	Heavy
V	1800-2600	25-35	Deep	moderate to semi-heavy
VI	1800-2600	65-75	Deep	Heavy
VI	1800-2600	65-75	Deep	moderate to semi-heavy
V	1800-2600	45-55	Deep	Heavy
V	1800-2600	0-25	Shallow	semi-heavy
IV	1800-2600	34-45	Deep	Heavy
IV	1800-2600	34-45	Deep	moderate to semi-heavy
VII	1800-2600	> 75	Deep	moderate to semi-heavy
V	1800-2600	25-35	Shallow	semi-heavy
V	1800-2600	45-55	Shallow	semi-heavy
VI	1800-2600	65-75	Shallow	semi-heavy
VII	1800-2600	> 75	Shallow	semi-heavy
V	1800-2600	34-45	Shallow	semi-heavy
IV	1800-2600	0-25	Semi-deep to deep	semi-heavy
IV	1800-2600	25-35	Semi-deep to deep	semi-heavy
V	1800-2600	55-65	Semi-deep to deep	semi-heavy
V	1800-2600	55-65	Shallow	semi-heavy
VI	1800-2600	65-75	Semi-deep to deep	semi-heavy
V	1800-2600	34-45	Semi-deep to deep	semi-heavy

The forest suitability assessment is presented in Figure 36 and the respective area calculation is given in Histogram 14.

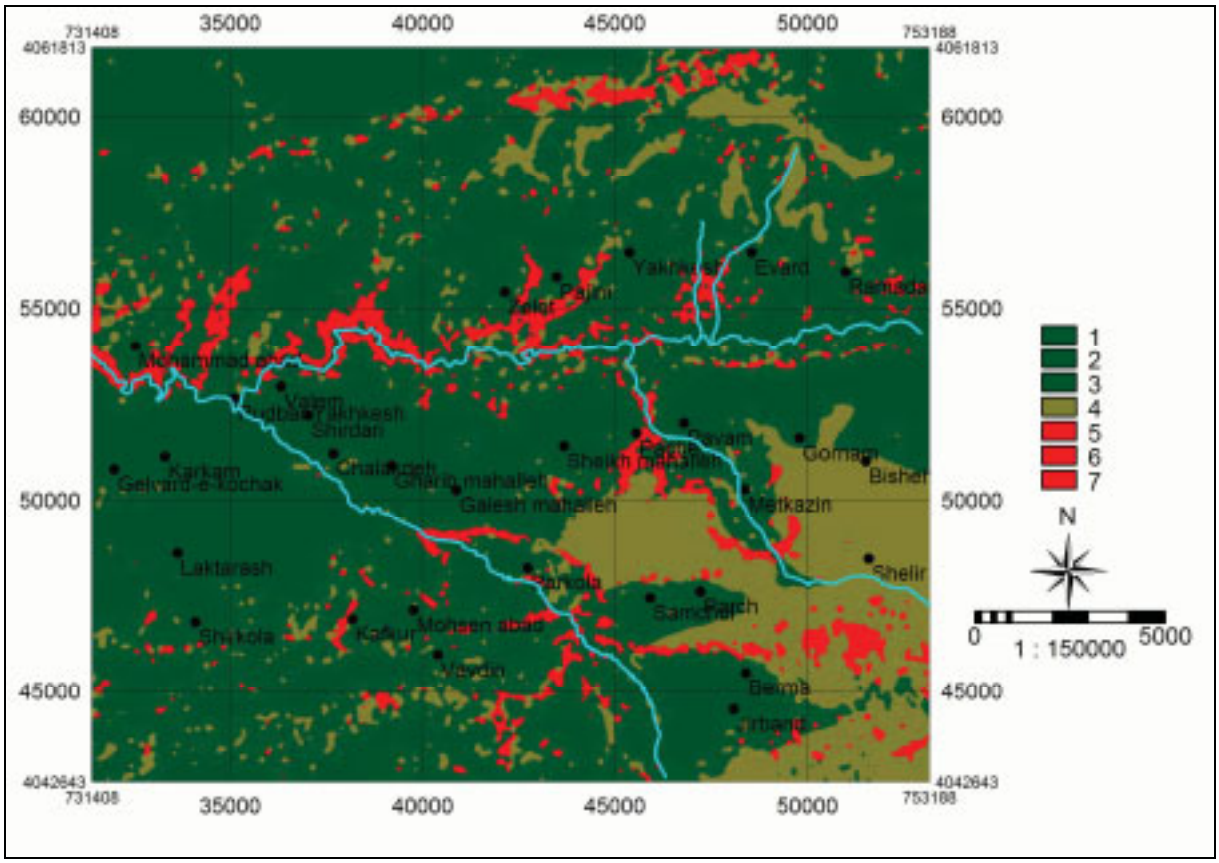
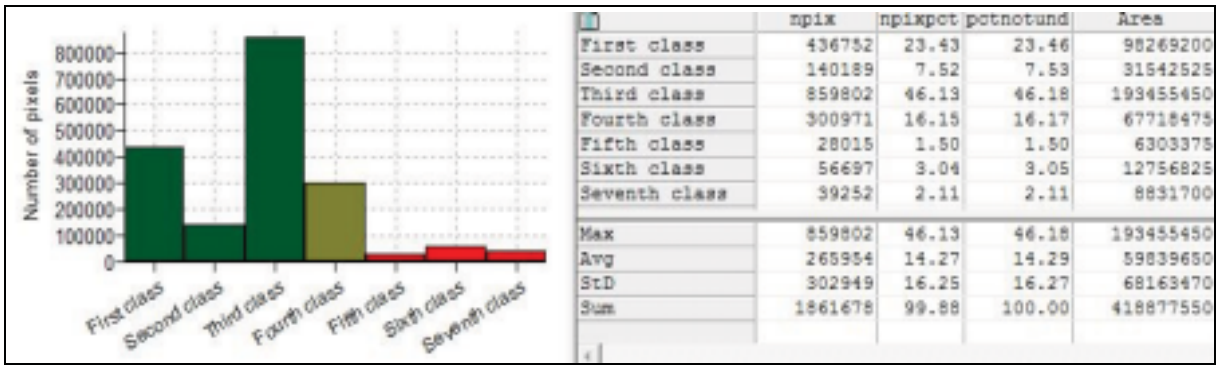


Figure 36: Suitability for forestry and afforestation in the entire study area (according to Table 8)



	npix	npixpct	pctnotund	Area
First class	436752	23.43	23.46	98269200
Second class	140189	7.52	7.53	31542525
Third class	859802	46.13	46.18	193455450
Fourth class	300971	16.15	16.17	67718475
Fifth class	28015	1.50	1.50	6303375
Sixth class	56697	3.04	3.05	12756825
Seventh class	39252	2.11	2.11	8831700
Max	859802	46.13	46.18	193455450
Avg	265954	14.27	14.29	59839650
StD	302949	16.25	16.27	68163470
Sum	1861678	99.88	100.00	418877550

Histogram 14: Area estimation of different suitability classes for forestry and afforestation

Around 12981 ha (31%) of the entire area has first and second class potential for industrial forest management activities. Class 3 even covers 19345 ha (46%) of the area. Consequently, the major part of the area (77%) has very well to moderate ecological conditions for industrial forestry. Another 6772 ha (16%) of the area has potential for afforestation as class 4. The final 2788 ha (7%) of the entire area, which are of minimum suitability for timber production

(forest suitability classes 5-7) could easily be assigned for conservation purposes without causing conflicts with other interests.

Figure 37 further distinguishes the suitability degree of the present forests of the study area, taking also their actual crown cover (dense and sparse) into consideration, thus representing the current situation in a more realistic way. Histogram 15 represents the respective area balance. These results indicate that around 53% of the present forest area is covered by dense forests of suitability class 1 to 4, which indeed is supposed to be suitable for industrial forest management. However, the sparse forests within this 1 to 4 suitability classes which would need and should be assigned for implementing a rehabilitation and afforestation program, already do amount to 38.3%. Another 2123 ha (8.6%) are beyond any timber production interests (classes 5 to 7) and should be protected for soil, water and wildlife habitat protection. More than half of them might need special care with respect to their low crown cover.

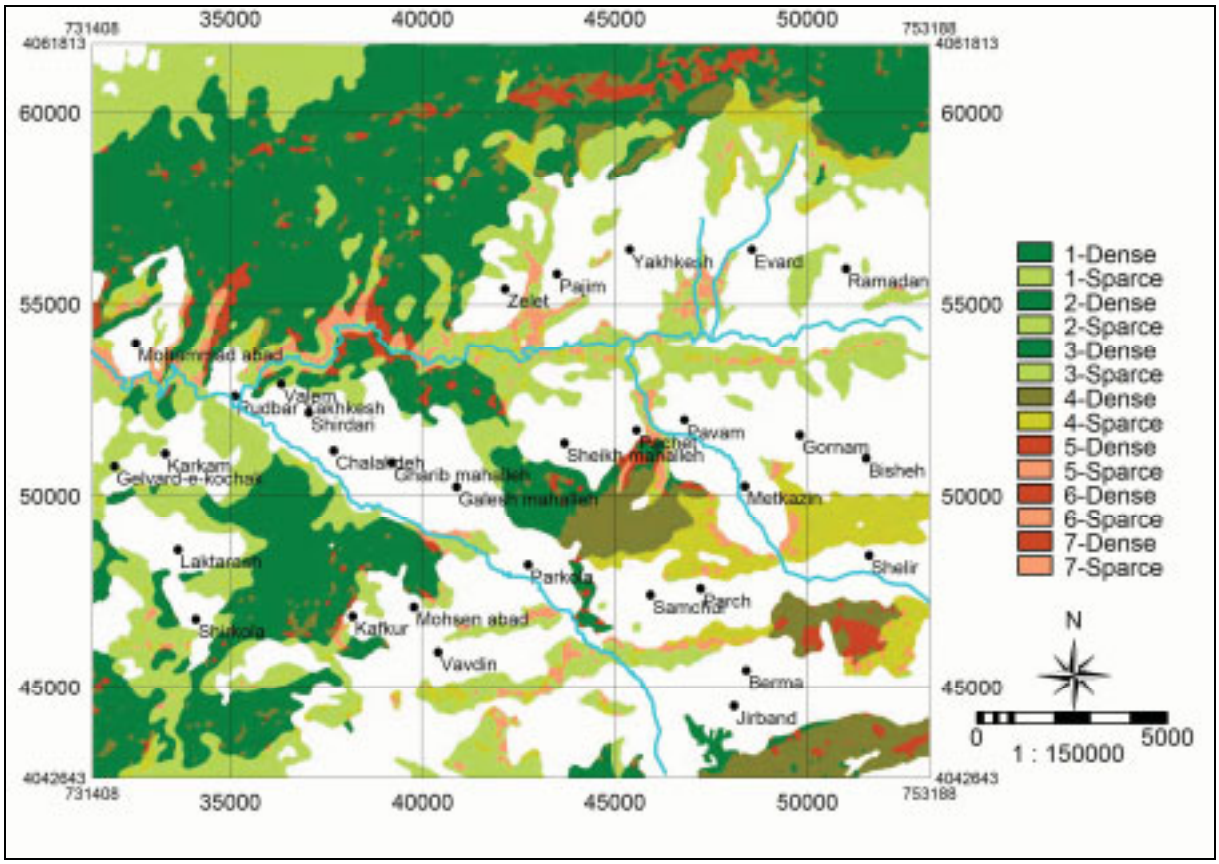
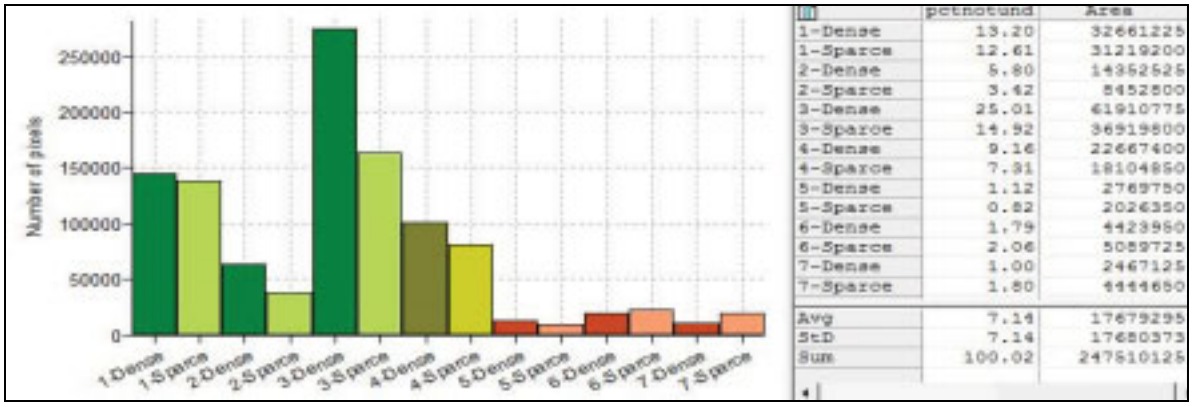


Figure 37: Suitability classes of the current forest areas (according to Table 8) with respect to their canopy density

By deducting the current arable lands from Figure 36, the potential suitability map of these areas for reforestation and forestry was produced (Figure 38), with the respective area calculations as given in Histogram 16.



	potnotund	Area
1-Dense	13.20	32661225
1-Sparce	12.61	31219200
2-Dense	5.80	14352525
2-Sparce	3.42	8452800
3-Dense	25.01	61910775
3-Sparce	14.92	36919800
4-Dense	9.16	22667400
4-Sparce	7.31	18104850
5-Dense	1.12	2769750
5-Sparce	0.82	2026350
6-Dense	1.79	4423950
6-Sparce	2.06	5089725
7-Dense	1.00	2467125
7-Sparce	1.80	4444650
Avg	7.14	17679295
StD	7.14	17680373
Sum	100.02	247510125

Histogram 15: Area estimation for the suitability classes of the current forest areas (according to Table 8) with respect to their canopy density

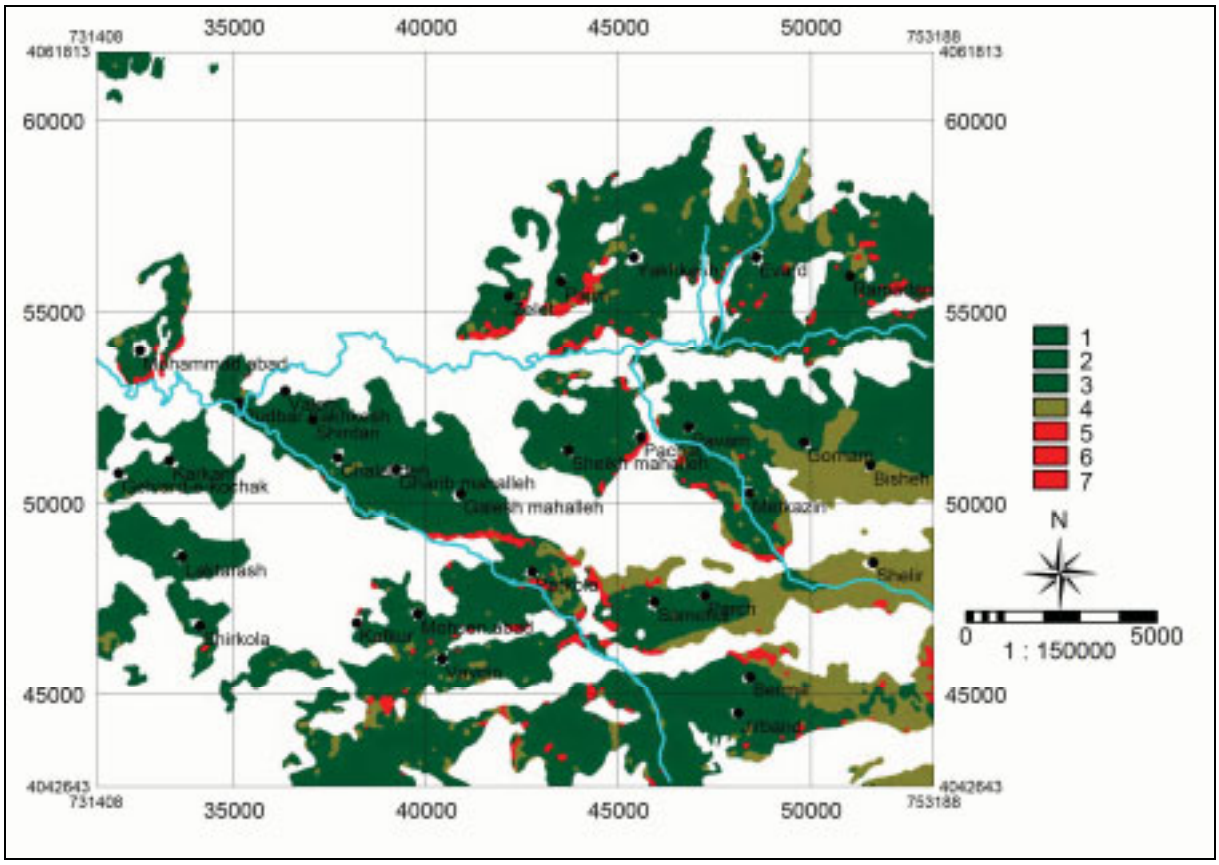
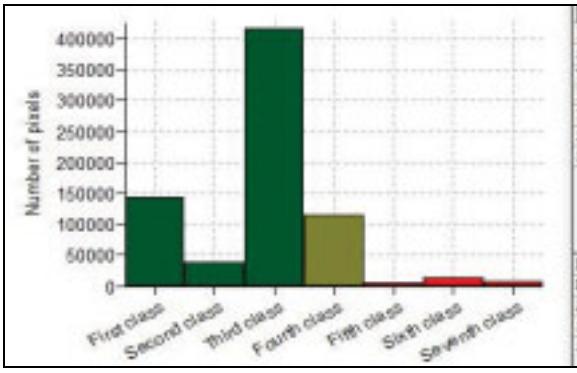


Figure 38: Potential suitability classes of the current arable lands (according to Table 8) for reforestation and forestry

Surprisingly, this map and its area calculation reveal that around 621 ha (3.7%) of the cultivated area would not even be of interest for timber production (classes 5-7) while a consider-

able 16022 ha (96.3%) could be reforested, from the forestry point of view. However, this view does partly compete with agricultural demands. Thus, a further map was introduced by extracting the unsuitable areas for agricultural activities (class 7) from the agriculture suitability map and crossing it with the Figure 38. This new map (Figure 39) contains the potential areas for reforestation or other biological measures for soil and water protection, which might cause no or minor conflicts with local farmers interests. These potential reforestation areas for soil and water protection do account for 5343 ha.



	npix	npixpot	potnotund	Area
First class	142983	7.67	19.33	32171175
Second class	37696	2.02	5.10	8481600
Third class	415676	22.30	56.20	93527100
Fourth class	115746	6.21	15.65	26042850
Fifth class	6166	0.33	0.83	1387350
Sixth class	13530	0.73	1.83	3044250
Seventh class	7892	0.42	1.07	1775700
Min	6166	0.33	0.83	1387350
Max	415676	22.30	56.20	93527100
Avg	105670	5.67	14.29	23775718
StD	147292	7.90	19.91	33140666
Sum	739689	39.68	100.01	166430025

Histogram 16: Area estimation for the suitability classes of the current cultivated areas for reforestation

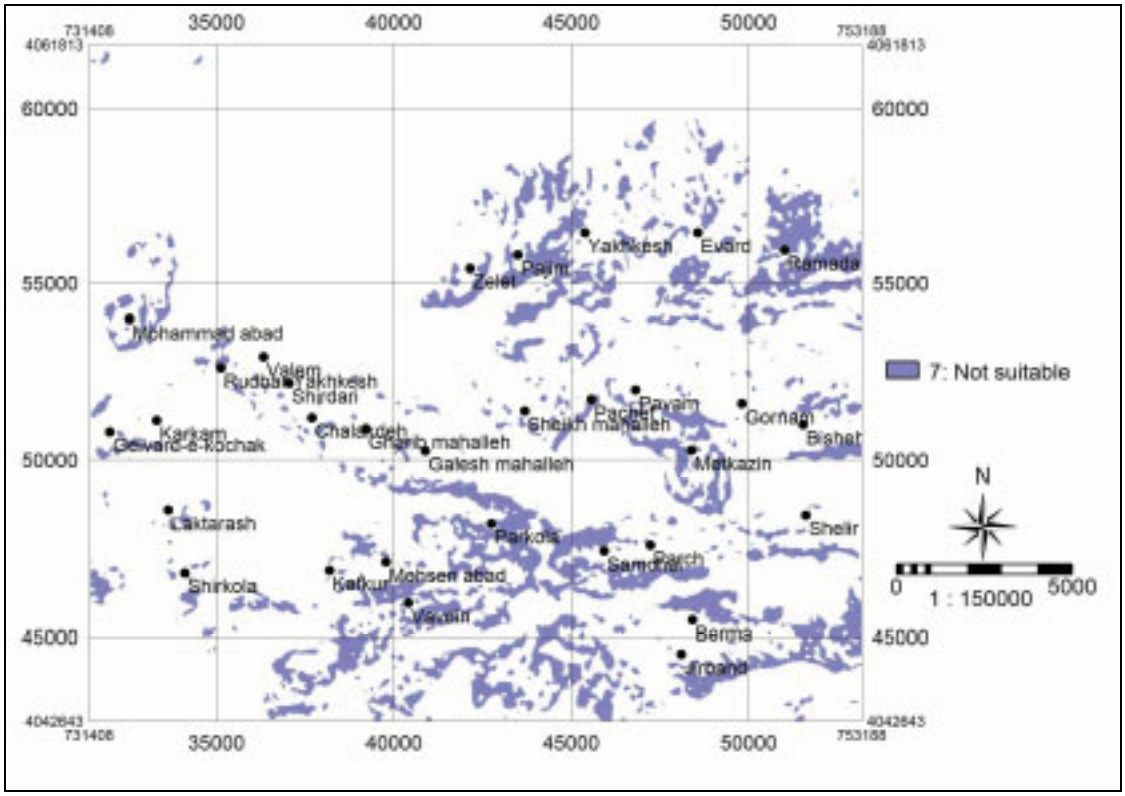


Figure 39: Potential agricultural areas for reforestation

It should be mentioned that considering such competition between forestry and agriculture are not a usual integral part of the Iranian assessment approach. However, the presented assessment results do illustrate that such consideration and weighting between different opportunities lies within the capabilities of the Iranian approach.

5.3 Landscape assessment following some principles of the German approach

In order to better adjust the land use planning to soil and water protection, the following assessment identifies the important areas for natural resources conservation and landscape protection following the principles of landscape planning in Germany. The results can serve as useful guidelines for decision-making among current and alternative land uses on a local scale. These planning aspects (regulation functions) are neglected in the Iranian approach, which focuses more on the production functions (land uses). However, constricted by the rather limited available information, the following questions were considered as general guidelines in order to achieve this task:

1. Which agricultural surfaces (LAWI) have high erosion potential? (Surfaces with an inclination above 15%)
2. Which surfaces are suitable for cultivation? (Surfaces with an inclination below 15%, enough soil depth and suitable texture)
3. Which forest surface is potentially threatened by erosion? (In terms of the canopy cover and inclination)
4. Where are the results of question 3 situated in the proximity (1500m distance) of the villages? (Which erosion-sensitive forest surfaces should be preserved for soil and water protection near villages and could be threatened by agriculture or domestic uses near villages?)

Concerning the agricultural suitability as assessed so far, additional restrictions were included:

a) A 500 m distance to the rivers was considered in order to prevent nutrient entries into the water system[20].

b) Heavy soil textures were excluded in order to prevent soil erosion by run-off

This analysis was made in the ArcGIS9.2 environment. For this purpose, all of the necessary data layers of the Yakhkesh area were transformed from ILWIS 3.4 format to the Arcview

[20]) A distance decrease from 500 m to 250 m just added approximately 45 ha to the usable surface. Therefore, considering the danger of potential nutrient entries and the safety of the riverbank led to the acceptance of the 500m buffer. Nevertheless, a concrete analysis of the local condition of the banks and the kind of the agricultural use might allow a reduction of the minimum distance, if necessary.

Shape files and then unified into one projection system (UTM, WGS 84, and Zone 39N) using Arc-catalogue tools.

5.3.1 Agricultural suitability, considering soil and flowing water protection

Based on the available data layers, the proper conditions for agricultural use are defined as follows:

- The slope degree may not exceed 15 %
- The soil depth must at least have 80 cm amount ("Semi-deep to deep" and "Deep" classes)
- The soil texture should not be heavy (excluding Heavy and Semi-heavy classes)

The slope degree map of the area was used for delineation of the potential erosion areas. The 8 inclination classes were divided into two ranges, among which the so-called "level, sloppy, gently sloppy, strongly sloppy and moderately steep" are considered as "no-erosion" class. The others, including the "steep, very steep and extremely steep" classes were assigned as "potential erosion" class. The no-erosion class was then selected as a new shape. Areas with suitable soil textures (i.e. the "moderate" and "moderate to semi heavy" ones) were then respectively selected from the soil texture map and transferred into a new shape. In fact, the remaining classes, i.e. "heavy and semi- heavy" were excluded. Areas with a proper soil depth were selected form the soil depth map, which include "deep and semi-deep to deep" classes.

The so-called "positive" map was produced by intersecting the proper slope and soil shapes: "no erosion risk", "suitable soil texture" and "appropriate soil depth". This map includes areas with all of the positive conditions. Regarding a 500 m distance of the arable lands to the rivers, a buffer shape was produced and then erased as improper areas (inside the buffer) from the "positive" map. The so-called "LAWI_positive" is the result shape and the final answer to the second question showing those parts of the study area, which are ecologically applicable for agricultural use (see Figure 40). Such sites are remarkably concentrated in the south-western part of the study site, where the areas have low inclination and soils have been developed very well, mostly under the climax vegetation cover. It further has to be stressed, that they only amount to less than 4% (around 1510 ha) of the entire land surface and that surprisingly they are not really those, which are currently used as farmlands, but have still remained under forest cover (Figure 40). However, this is why they are legally not available for cultivation.

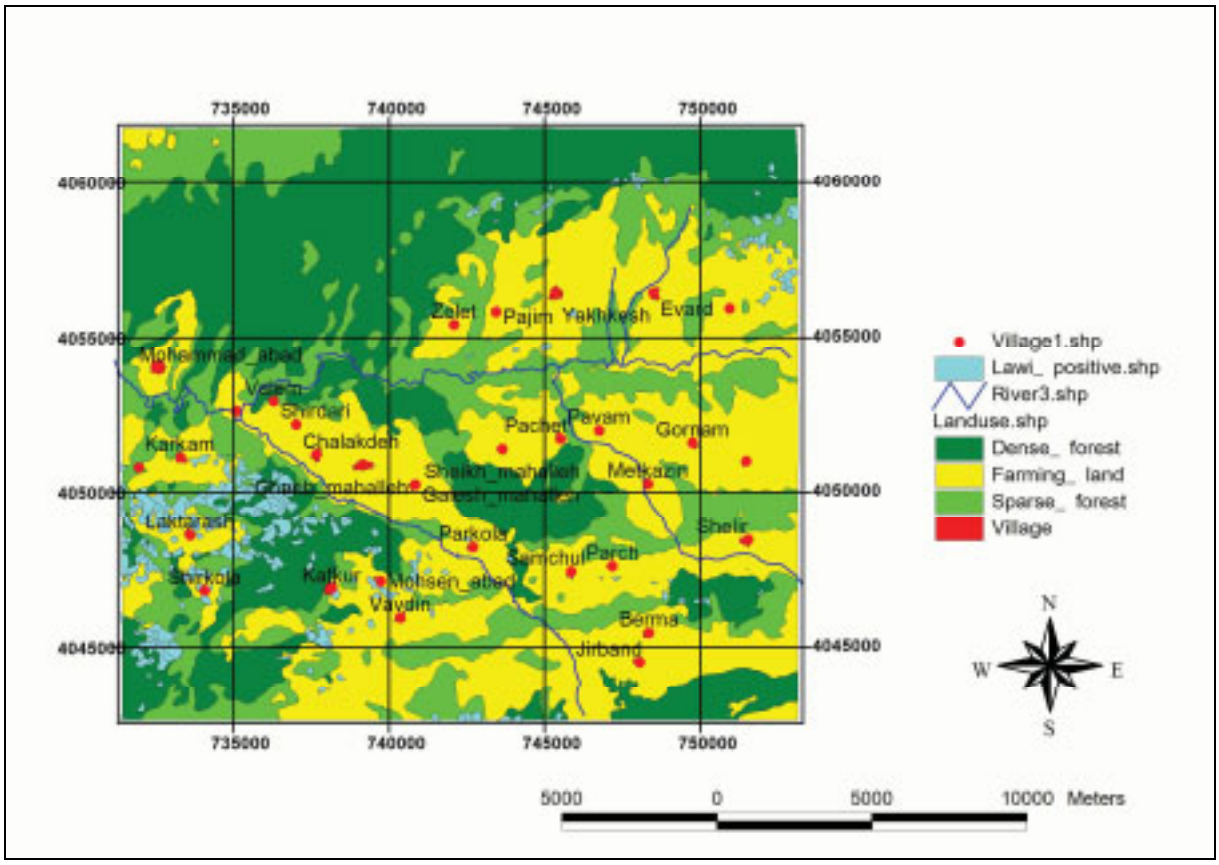


Figure 40: Suitable areas (LAWI_positive) for agricultural activities

5.3.2 Protective forests under pressure

The next step was to identify those forests, which are subject to high erosion risk. To achieve this, the sparse forests on the steep slopes were considered as the potential areas. The shape "forest" includes two density classes, i.e. "sparse" and "dense". By selecting the class "sparse", the new "sparse forests" shape was produced. Then, the sparse forest surfaces with a low slope degree (from the slope-classified map, Figure 16) were erased from the "sparse forests" map. The result is shown in Figure 41, which covers an area around 9071 ha and represents the low canopy forests that are located on the steep slopes and, consequently could be threatened by soil erosion. Additionally, the shape "forest_only" was clipped with the 1500 m buffer shape around the villages (village_Buffer1500), as the new shape "forest_only_village" (Figure 42), to delineate the erosion potential for forests in the direct vicinity of the villages, since these forest surfaces need urgent conservation and rehabilitation measures. These forests cover an area around 1984 ha and are important to decrease the risk of landslides around the settled areas.

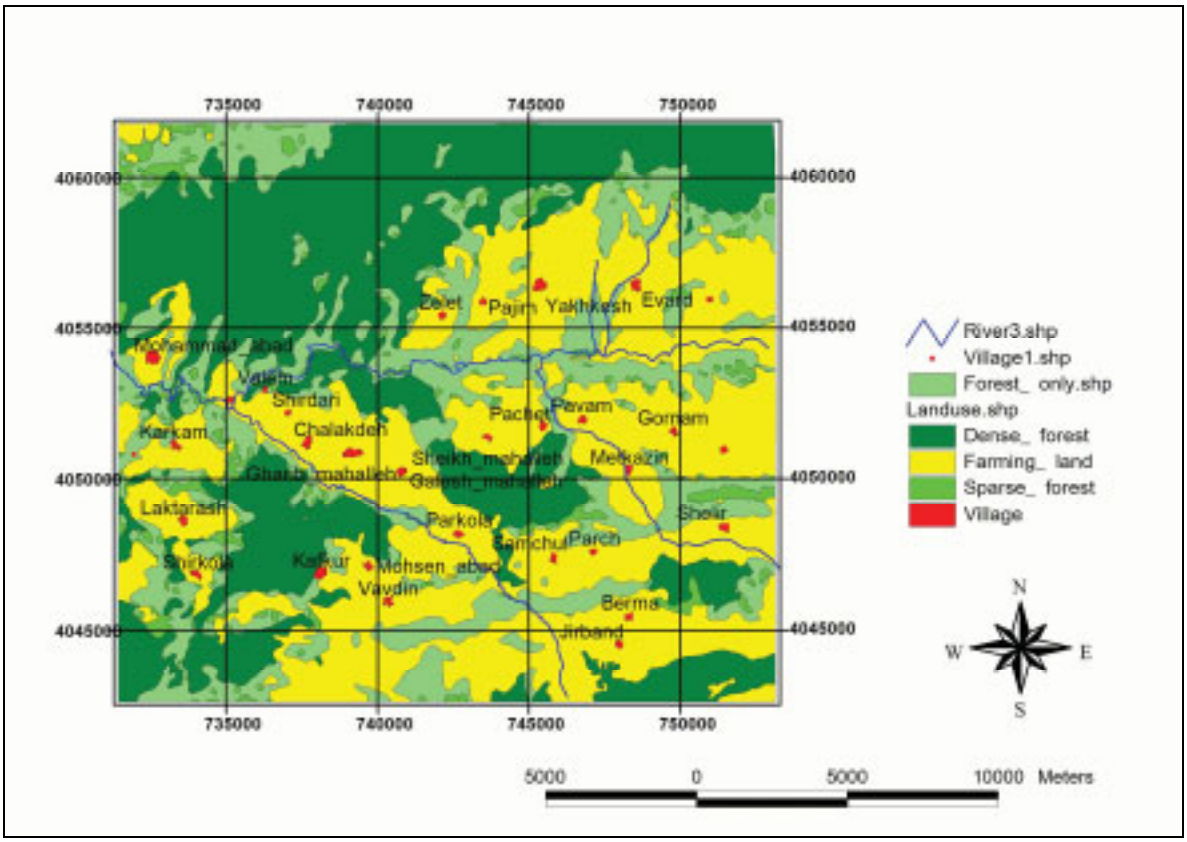


Figure 41: Protective forest surfaces for soil and water

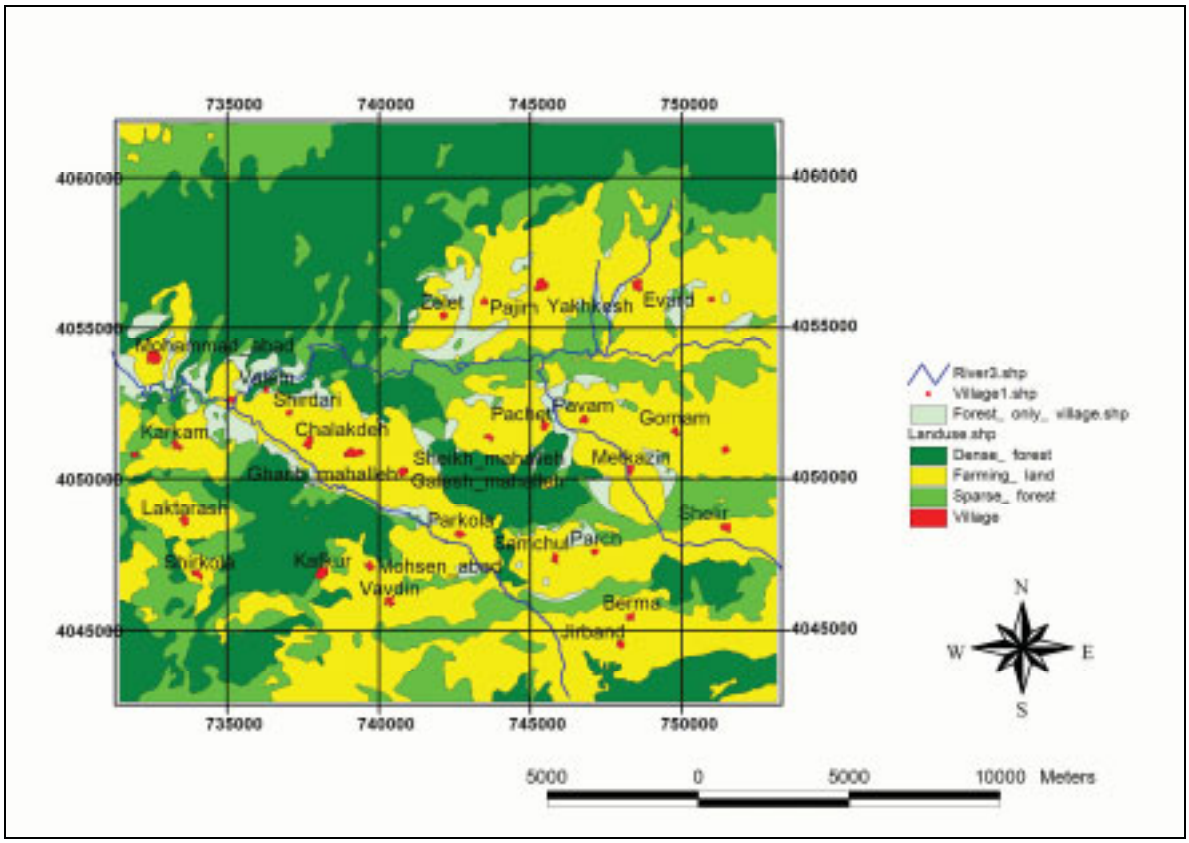


Figure 42: Protective forest surfaces for soil and water near the villages (1500m buffer)

5.4 Social evaluation of the assessment results and choice of alternatives

In the second phase of the social assessment, we asked the experts and villagers to describe their ideas about the planning results and their suggestions for possible measures to combat the major reasons of the forest loss in the Yakhkesh and other mountain forest areas of the Caspian region. However, the experience of the pre-assessment phase in 2005 showed that there are many restrictions towards achieving this goal. The main reasons are the lack of environmental awareness among the local people, dominant sectoral planning of the administrative bodies and a general lack of knowledge and experience concerning community-based and integrated planning approaches. In fact, the major number of the interviewees (more than 89% of the experts and around 98% of the villagers) tended to discuss the practical implications of the results rather than the theoretical or technical aspects of the suggested approach. Interviewees in the expert group were more interested in "W*hat could be suggested?*" than "W*here or why should it be suggested?*" and "*Is it really appropriate there*". Meanwhile, the local villagers spent more attention to the financial supports from the Government, to economic benefits and to the "compulsory" and "voluntary" aspects as well as to possible punishments or fines. In other words, there was by far less discussion on the selected criteria for the suitability assessment than on the possible solutions to combat the major reasons of the forest loss and their ecological and economic aspects.

In the second assessment phase, we tried to meet these facts by collecting all of the previous and current successful experiences from different projects and presenting them in a systematic but simple manner to get to know the level of acceptance or agreement among the experts and the villagers. Depending on their level of acceptance, the respective measures and activities could be suggested. With respect to this goal, the following general hypothesizes were put behind to define the appropriate questions to both, experts and villagers:

- Increasing the harvest of agricultural products by introducing new environmentally sound alternative livelihoods, flanked by the necessary financial, training and technical supports will lead to a remarkable decrease of forest loss, caused by land conversion
- Semi-intensive cattle raising, flanked by the necessary organizational, technical and financial supports will solve the current problem of forest destruction, caused by cattle raising in the rural mountain areas

- Strengthening the fossil fuel network, flanked by the improvement of the traditional heating system, and the introduction of alternative energy sources, will result in a huge decrease in forest loss caused by firewood collection and charcoal production in the rural areas
- The best way to rehabilitate the degraded forest areas will be afforestation, using endemic species or fast-growing endemic or exotic species (deciduous as well as coniferous trees)
- Afforestation and preservation are the better alternatives to rehabilitate the degraded forest sites, which are surrounded by agricultural areas rather than converting them to other kind of land uses
- Re-establishment of biological connections between fragmented forest patches can be done by developing a network of hedgerows and additional groves with multiple ecological and economic benefits

The answers and opinions of the experts and villagers are presented in the following sections:

❖ How to combat forest loss, caused by land conversion

So far, land conversion used to be a hidden but continuous process that was mainly hindered by means of a "fence and guard" strategy of the FWRO. However, in spite of the legal fines, villagers continued this process due to cultural and - more important - economic constraints. We asked the experts about the best alternatives to combat forest destruction caused by the agricultural land conversion.

Around 19% suggested that it could be stopped by increasing control measures and severer punishments! However, the rest believed that it could be decreased by increasing the total production and income. Around 68% counted on motivating the villagers to cultivate on the ecologically suitable lands only, and 62% believed in a more effective utilization of the fertilizers, pesticides and genetically improved races. Using the mentioned approach in the UNDP-GEF project the total production of the wheat can be increased from below 1 to 3.5 (even 5.5) tons/ha (Yakhkeshi 2005). Around 58% suggested alternative cultivation of the garden (for fruit) or fast growing (timber) tree species, another 51% voted for fodder (alfalfa) cultivation and 45% suggested cultivation of pharmaceutical plants on the sloppy farmlands.

Around 38% thought that assigning green taxes, loans and other financial supports might substitute the low levels of income and decrease the dependency of the villagers on the forests. Another 55% suggested to promote community-based activities like eco-tourism, aquaculture, poultry production, apiculture, silkworm farming, handicraft and dairy production in rural cooperatives.

Although, near 87% of the villagers negated their current contribution in such activities, 88% announced their willingness to cooperate in promising economic activities or in those that provide special financial supports. Among the above mentioned activities, 67% emphasized the more effective utilization of the agricultural materials under the supervision of the knowledgeable experts, 51% opted for the cultivation of fast growing tree species, fruit or pharmaceutical plants, 37% for fodder cultivation. 76% believed that the government should also assign special financial supports to the villagers who live in the upstream for protection of the forests, pastures and soils. 63% announced their readiness for participatory activities, with a fair distribution of the economic advantages among the members.

It seems that establishment of the Yakhkesh multi-purpose cooperative company during the UNDP-GEF project has successfully increased the social capacity and awareness for participatory activities. However, the recent study and interviews with the local people also made clear that such participatory activities need continuous and strong support and supervision from the government organizations as well as the cooperation of the higher educated members of the local societies. Otherwise, the lack of democracy and education might lead to a misuse of their wealth and trust.

❖ How to combat forest destruction, caused by cattle raising

Livestock grazing is a supplement livelihood activity for the major part of the rural society in the mountain forest areas which causes continuous forest destruction. So far, the government has not been able to find a proper and fair solution for this problem. Although the dominant idea in the FWRO' plan is that it should be quitted as soon as possible, there is no consideration concerning the current and future negative impacts on the rural society. Meanwhile, the lack of knowledge, insufficient fodder resources and poverty force cattlemen and villagers to continue this activity, even illegally.

Fortunately, only 8% of the experts still believed that it must be quitted as soon as possible and another 19% suggested it could be restricted to the ecological capable areas by

introducing a Silvo-pastoreal system (see Ghazanafari, 2006). The major part of the interviewees preferred to promote semi-intensive cattle raising by:

- Establishing rural dairy cooperatives for proper organization of the cattlemen and fair distribution of the monetary and non monetary supports and benefits (55%)
- Establishing animal husbandry stations near the villages to exit and aggregate the livestock from the forest (57%)
- Genetic improvement of the local races to increase the total dairy production as well as decrease the move ability of the cattle (49%)
- Cultivation of fodder crops to decrease the grazing pressure on the forests (43%)
- Training and technical/financial supports of the cattlemen and villagers for the activities mentioned above (55%)

Around 77% of the villagers were willing to cooperate in patrolling, conservation and afforestation of the degraded areas. However, most of them were only eager to cooperate in activities that get strong support from the government. This is mainly due to their poverty, which makes them concentrate on the short term advantages, rather than keeping possible long term benefits in mind. The advantages of a community-based animal husbandry strengthened by a rural cooperative do not seem to be clear for most of the villagers (76%). Thus, more education and propagation activities are needed in this respect.

Around 37% of the villagers were eager to cultivate fodder crops, which have better nutritional values than forest foliage and may result in more dairy products. It is astonishing that villagers do prefer to use fodder from other provinces rather than producing it by themselves. Regarding the current prices, the total production cost for alfalfa amounts to around half of the final market price. Thus, it is even an economic alternative to the wheat cultivation, especially on the sloppy farmlands. The lack of information and of a proper distribution and marketing system led to such misguided idea among the local villagers.

❖ How to decrease forest loss caused by firewood collection and charcoal production

Regarding firewood collection and charcoal production, 51% of the experts believed that strengthening of the fossil fuel networks was the best alternative to decrease the pressure on

the forests. However, the fuel price would have to be adjusted to the narrow economic conditions of the villagers. Another 26% mentioned that using more effective stoves and other new heating systems could decrease the firewood consumption. Around 64% believed that this problem could also be solved by promoting the utilization of alternative sources of energy, like bio-gas or small hydro power plants. 23% suggested firewood cultivation on the degraded farmlands.

Silk worm culture was traditionally done in most of the villages during the previous decades. Mulberry leaves are uses for feeding the silkworms and the branches are used as firewood. Re-establishment of this traditional livelihood system could play an important role in improving the economic conditions of the villagers and providing jobs for women and youth. In those forest areas with a forest management plan, the needed fuel wood could also be provided from the wind fallen trees or from trees that are improper as high quality timber.

The major part of the villagers (88%) argued that using firewood and practice firewood collection was a traditional right and should be ensured for the villagers further on. However, around 56% believed that they might substitute their current heating system by new alternative energies, if the government provided the needed financial supports.

❖ How to rehabilitate the degraded forest areas

When asked about the best alternatives for the rehabilitation of the degraded forest areas, only 4% of the experts suggested using fast-growing coniferous tree species, while 8% voted for fast-growing deciduous tree species. However, the awesome majority (91%)[21] of the interviewees suggested afforestation by the endemic tree species. It might also be an alternative to use the fast growing deciduous tree species as pioneers and then gradually substitute them by the endemic climax species. This could especially suit those forest surfaces where the establishment of a denser crown cover is essential for soil and water protection. However, any decision should be made in agreement with the consultation of the stakeholders.

In parts of the study area, some sparse forest patches have remained, surrounded by farmlands and their future existence is in question. Around 36% of the experts believed that these areas should be conserved and that natural regeneration should be ensured to rehabilitate them. Another 38% suggested afforestation and conservation. Only 19% of the participants believed

[21] Double marking was allowed

that these areas should be converted to fast-growing plantations for timber production, and 25% suggested that they should be used for agro-forestry. Only a small part of the interviewees (2%) thought that, these areas should also be converted to pastures or farmlands.

Around 83% of the villagers preferred that these areas were affiliated to them for agro-forestry, timber production or cultivation. Only 11% agreed to leave them untouched. This result does highlight why it is usually difficult to safeguard residual forest patches, especially since most of them are suitable for agro-forestry activities. Agro-forestry thus might be the best solution for degraded forests, as a multi purpose land-use for producing wood, honey, silk, fish (along the river or near the springs), mushroom, fruit and fodder crops. It even fits to ecotourism if ever recreational parks should be established.

❖ How to re-establish biological connections between fragmented forest patches

We finally asked experts and villagers what they thought to be the best way for re-establishment of the habitat connections between fragmented forest patches. Around 38% of the experts suggested buying the farmlands between the patches and then reforest them. Another 55% suggested to establish a network of small buffer zones and hedgerows within the farmlands, while 15% believed that stripes of fast-growing plantations should be laid out, which consider both, the ecological and the economic benefits. Additionally, 78% of the experts were convinced that the type and width of such corridors should be designed based on the local ecological conditions and stakeholder consultations. On the other hand, around 32% of the villagers stated that this was none of their problems and that they did not want to participate in any measures. However, around 26% were ready to sell a part of their farmlands for such purpose, but for a reasonable price only. A considerably higher portion, namely 67% were disposed to dedicate a part of their farmlands for combined measures, i.e. economically as well as ecologically oriented, however with technical and financial supports of the responsible organizations.

5.5 Recapulating compilation of the ecologic and community assessments' outputs

Table 9 is a recapulating compilation of the main outputs of the ecological and the community assessments in order to check systematically whether everything fits well together or whether there are contradictions and conflicts. The results show that conflicts may arise in the medium and low suitability classes of the both arable lands and forests (especially, sparse forests) concerning the new proposed measures. Villagers' view and perception on their farmlands as "property" led to this fact that any other proposed measure except cultivation on their low or unsuitable farmlands might result in losing their property. They strongly want to keep their farmlands, no matter whether they use or not use it for cultivation. This is mainly resulted from the lack of community or private forest ownership in addition to the state forests, which decreases the community interest for assigning such farmlands for other alternative activities, e.g. timber production. It should be emphasized again that local communities receive no significant profits from the forestry and afforestation plans, which are mainly prepared by the FWRO and executed by the private enterprises. On the other hand, the experts' idea reflects the top-down monopoly view of the Government, which tends to confiscate unsuitable areas and give them back to natural conditions, as forests for soil and water protection or timber production. However, it is not impossible to change the people's idea for a collaborative preservation of such areas, through public-awareness and introducing sustainable livelihood alternatives. The same situation could be raised for the low suitable and unsuitable forests, especially the so-called "sparse", i.e. degraded forests, which are fragmented or have no forestry plan. Again, villagers traditionally see these areas, as potential areas to expand their farms, as well as, to introduce other kind of domestic uses. However, experts strongly believe that these areas should be rehabilitated and reconnected. This problem could be solved by an integrated program that fulfills the domestic needs of the villagers for livestock grazing, timber extraction and fuel wood collection by other sustainable alternatives, namely Agro-forestry. Additionally, the execution of a community-based forestry plans could change the villagers view on such forests as "Public asset" to "their property" in order to decrease community desires or needs for any violation, illegal logging or over-utilization of such areas.

Table 9: Compilation of the ecological and community assessments

Natural resources	Ecological assessment results: state/problems	Community assessment results: views/expectations	proposed measures	Experts acceptance level[22]	Villagers acceptance level
Arable lands	High suitability for agriculture	Current cultivation practices	Increase the total production by new techniques, training & financial supports	2	2
	Medium suitability for agriculture	Dry-farming (DF)	Increase the fertility, soil preservation techniques, fodder cultivation, pharmaceutical plants, orchards, wood cultivation	2	2
	Low suitability	DF or livestock grazing (LG) or Orchard	soil preservation techniques, Agro forestry for fodder, fruit and wood	2	3
	Not suitable	Fallowed DF/ LG	Nursery covers, afforestation	2	4
Dense Forests (Not fragmented)	High suitability for forestry	Domestic timber (DT), cattle raising (CR), fuel wood (F), hunting (H)	Community-based Forestry (CBF) based on the traditional right of use and borders, balancing the domestic needs (BDN) by semi-intensive CR, fossil fuel, Bio-gas, fodder & wood cultivation in marginal areas	2	2
	Medium suitability for forestry	DT, CR, F, H	CBF & BDN	2	2
	Not suitable (Preservation, P)	F,LG & H	Preservation for soil and water protection	2	3
Sparse (Degraded) Forests (Not fragmented)	High suitability for afforestation & forestry	Conversion to new farmlands (CF), CR, LG, F, H	Afforestation then CBF and BDN	2	4
	Medium suitability for afforestation & forestry	CF, CR, LG, F, H	Afforestation (AFF) then CBF and BDN	2	4
	Not suitable (P)	F, LG & H	Afforestation and preservation	2	3
Dense Forests (Fragmented)	High suitability for forestry	DT, LG, F, CF,H	Reconnection by hedgerows or wood plantations (RHW), if possible CBF and BDN, if not preservation	2	2
	Medium suitability for forestry	DT, LG, F, CF, H	(RHW), then if possible CBF and BDN, if not preservation	2	3
	Not suitable (P)	DT, F, LG, H	RHW then preservation for soil and water protection	2	3
Sparse (Degraded) Forests (Fragmented)	High suitability for afforestation & forestry	DT, CF, LG, F, H	AFF and RHW, then CBF & BDN, if not preservation	2	4
	Medium suitability for afforestation & forestry	DT, CF, LG, F, H	AFF and RHW, then CBF & BDN, if not preservation	2	4
	Not suitable (P)	F, LG & H	AFF and RHW, then preservation for soil and water protection	2	3

[22] Acceptance levels: 1 (very good), 2 (good), 3 (neutral), 4 (poor) and 5 (very poor)

CHAPTER VI

RECOMMENDATIONS

6.1 Recommendations

According to the study results, it is obvious that the current land use in the Yakhkesh area is unsustainable, leading to gradual degradation and conversion of the forest surfaces towards maladjusted farmlands. Although a large part of the area is covered by farmlands, the assessment revealed that only a minor part of the respective sites is ecologically suitable for the current rain-fed cultivations. The current traditional system of agriculture and animal husbandry, which is the main sources of income for the villagers, is destructive and ineffective, leaving the villagers at subsistent levels that are even lower than for similar rural areas in the downstream. Besides its destructive nature and negative ecological consequences, it is threatening the future economic life of the inhabitants in the both, up- and downstream areas.

On the other hand, the management history shows that all of the previous programs or projects in the fields of forestry, agriculture, nature conservation and watershed management have been developed and executed in a completely sector-based top-down manner, without adequate attention to the consequences for the other sectors or for the society. Many remote mountain areas like Yakhkesh are under some kind of management programs that - in case of the forestry or nature conservation plans, even could not include the whole areas of their targeted land use.

This may shift and even accelerate the land use pressures on the areas with no management plan. In the Yakhkesh area for instance, only the forest surfaces in northern part of the Mehraban-Rood River are under effective protection of a management plan, while such a task has not or only weakly been realized for the southern forests. These are less attractive in terms of timber extraction, but are under sever pressures of the domestic uses. Although they also do fall under the jurisdiction of the FRWO, inadequate on-the-ground forest management capacities prevent an effective monitoring and enforcement of site boundaries and forest integrity.

At the same time, the government's emphasis on livelihood provision as well as the high levels of poverty in the surrounding areas precludes a strict, exclusionary boundary enforcement and encroachment prevention ('fences and guards') to conserve the forest resources. However, this approach does not seem to be appropriate (even not in the management areas) to prevent continuous land conversion and other man made pressures, especially firewood collection and cattle grazing. A quick look on the forest loss (around 1 to 2% per annum, based on the satellite imagery) revealed that the remaining forest patches had been gradually degraded to sparse forests, which were separated and then surrounded by the cultivation areas.

Without any integrated management plan, the remaining forests might disappear in the very near future.

Besides the biodiversity losses, the disappearance of the unprotected forests could cause huge flood events and their related social and ecological damages. So far, two huge flood events (1999 and 2001) have already happened in the adjacent areas. But above all, the villagers are getting poorer, the younger generations migrate to the cities and the farmlands are fallowed, due to the weak natural capacity and the lack of more sustainable alternatives.

Meanwhile the government organizations keep neglecting such sensitive areas or compete in spending a lot of money and time on plans, whose theoretical and practical aspects are even criticized by their staffs, as well as by the society. The results also show that the rural societies have lost their trustee on such plans, a fact that leads to repeated conflicts between the villagers and the government.

On the other hand, mountain forests and their dependent land use systems have great potentials for some kinds of environmentally sound activities that could improve and strengthen the economic conditions of the rural communities. The results of some national and international projects in the Yakhkesh, as well as, the adjacent areas show that many alternatives might be introduced and implemented in a participatory manner on both, government and society levels. However, these alternatives should be developed and implemented in an integrated and systematic manner, which have been the main weak points of previous similar attempts. Regarding the range of the assessment results, the following alternatives might be considered, as realistic future alternatives for the development of the area.

6.1.1 Alternative approaches

❖ The current top-down management approach

A “no-plan” scenario in which no alternative plan will be elaborated and the area will be managed under the current sector-based programs. These are mainly including forestry plans in the north of the river, some forestry plans in the eastern part which are still under development and some patrolling services for other forests, by FWRO. There is no DoE protected area in Yakhkesh, but patrolling by DoE staffs is done against illegal hunting. Some successful training and propagation programs are conducted for the villagers to increase the knowledge and awareness level about new agricultural techniques (like the FAO 1999-2000 and

UNDP-GEF 2001-2005) project. But they are not planned for a long time perspective and are not welcome in all of the villages.

The previous experiences however show that new lessons are forgotten soon, especially when the subsidies and other financial supports are finished. This is what exactly happened after the execution of the FAO project, in which free sapling, fodder seeds and chemical fertilizers were distributed to strengthen the vegetation cover on the sloppy farmlands and to prevent future floods (Nouri 2000). And, as it was already shown in Figure 30 and is included in Figure 43 again, forest destruction does not stop. Many unprotected dense forest patches in the south of the main river, have already lost their connectivity. As isolated forest patches, they are under high anthropogenic pressures. Thus, they might be converted to the degraded forests and then farmlands or pastures in the next 2 decades. Some of these somehow untouched areas however, are very important habitats for the wildlife species. The dense and sparse forests, which are located in the blue circles, host unique and very old stands of some endemic tree species, what makes them very important in terms of biodiversity, even across the Alborz Mountain. Unfortunately, all of them are surrounded by farmlands and are in the verge of destruction or degradation.

Under the current management programs in the forestry and agricultural sector, there is little hope to achieve a holistic management regime, which would look for realistic solutions that consider the habits, needs and capacities of the local people, while combating the negative ecological consequences of the fundamental anthropogenic pressures they exert on their natural environment.

Following the usual land use planning procedure, the suitability assessments are done for the entire planning areas, but will usually lead to a redesign of the current or possible land uses (see Figure 34&36). It is essential to realize that this approach implies or even enforces a fundamental but one-sided shift of land use, namely from farmland to forest land but not the other way round. At the same time, such shift in the most converted areas does assume that the respective land is conveyed to the state, leaving the people who did use it by common law without any compensation. In this case, such approach must cause immense and persistent social conflicts.

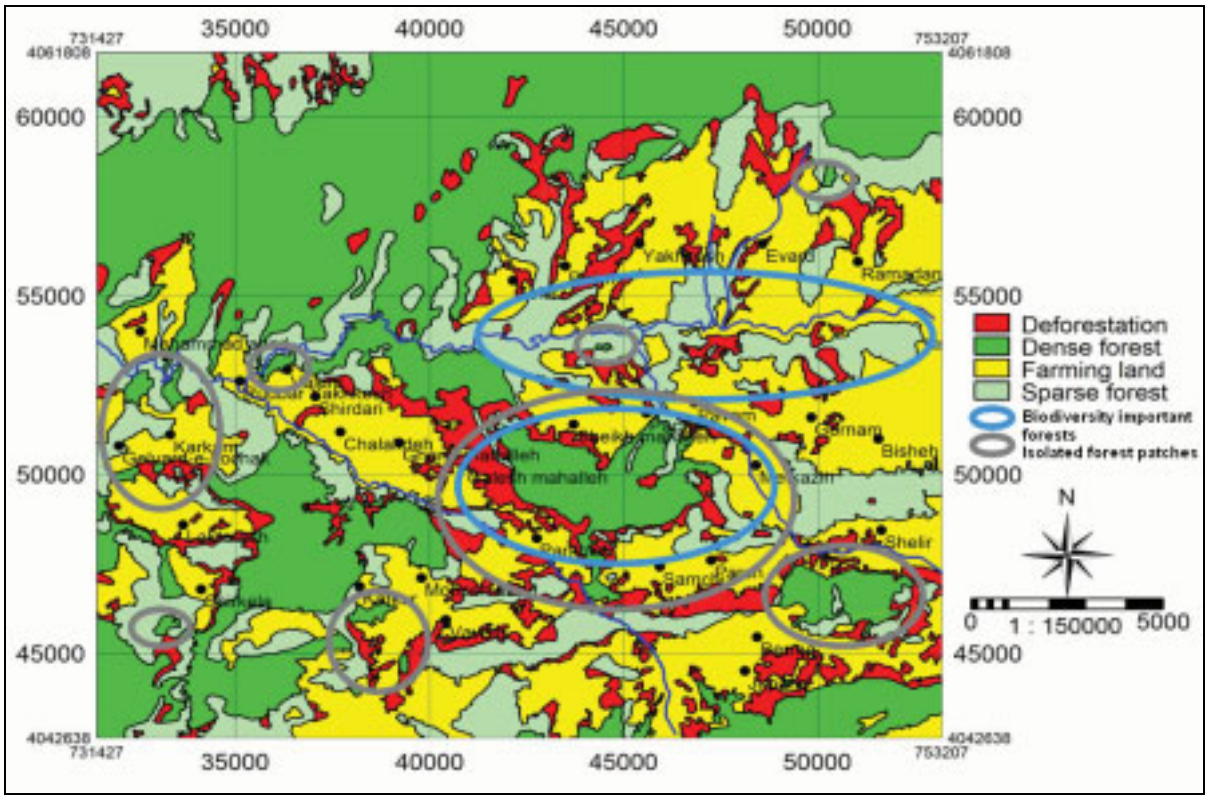


Figure 43: Biodiversity important but unprotected forest surfaces in the Yakhkesh area (Deforestation 1966-92)

❖ An integrated, discursive/participatory management approach

As an alternative approach to the usual procedure, this study suggests assessing the ecological suitability of the current land uses, to identify problematic areas and to reveal the root causes for their problems in order to find out the need for new sustainable solutions and to develop innovative, future oriented alternatives for the livelihood of the local people.

In this respect, the current farmlands have been assessed to determine their suitability degree for different agricultural uses and a correspondent process has been done for the forest areas, both in order to identify the need for sustainability improvement. Such an approach should prohibit the social conflicts that come along with the compulsory change of the land uses, especially in the cultivated areas.

In fact, the final discussion informed villagers and responsible organizations about the urgently necessary measures and the best alternatives in their territories, while demonstrating some options for participatory activities. The results led to practicable alternatives for agricultural activities, forestry and afforestation, which had been selected based on successful previous experiences and the social priorities of the rural society in the Yakhkesh area.

The suggested activities for the current farmlands are shown in Table 10 and Figure 44.

Table 10: Suggested alternatives for suitability classes of the arable lands in the study area

Suitability Class	Decision	Area (ha)	%
I & II	Current irrigated or Dry-farming	983	5.9
III	Fodder or Medicinal plants cultivation	47	0.7
IV	Dry-farming with improved techniques or Agro-forestry for fodder & wood	2785	16.4
V & VI	Wood plantations & fruit orchards	7476	44.0
VII	Nursery covers & reforestation	5341	32.0

The assessment results indicate that the current irrigated and dry-farming activities should be continued on around 983 ha (5.9%) of the current farmland land, with the first and second suitability classes only. The third class (47 ha) might be assigned for the cultivation of the medicinal or fodder plants. Dry – farming with a markedly improved utilization of the fertilizers and of ploughing methods could still be continued on around 2.785 ha (16.4%) of the farmlands in the fourth capability class, although these areas would be better assigned for sustainable agro-forestry activities. This may include the establishment of fruit orchards and the cultivation of the fodder crops (especially alfalfa) for semi-extensive animal husbandry, in order to increase the soil fertility and to prevent soil erosion. However, a large extend of the cultivated land, namely 7.476 ha (44%) have minor suitability for agriculture (fifth and sixth suitability class), which only allows activities like the establishment of wood plantations (for either timber or firewood supply) or for fruit orchards and cultivation of fodder crops or pharmaceutical plants. And undoubtedly there remain around 5.341 ha (32%) of the current farmland that do not show any suitability for agricultural activities at all so that the long term establishment of nursery covers and reforestation should be considered with respect to soil and water conservation.

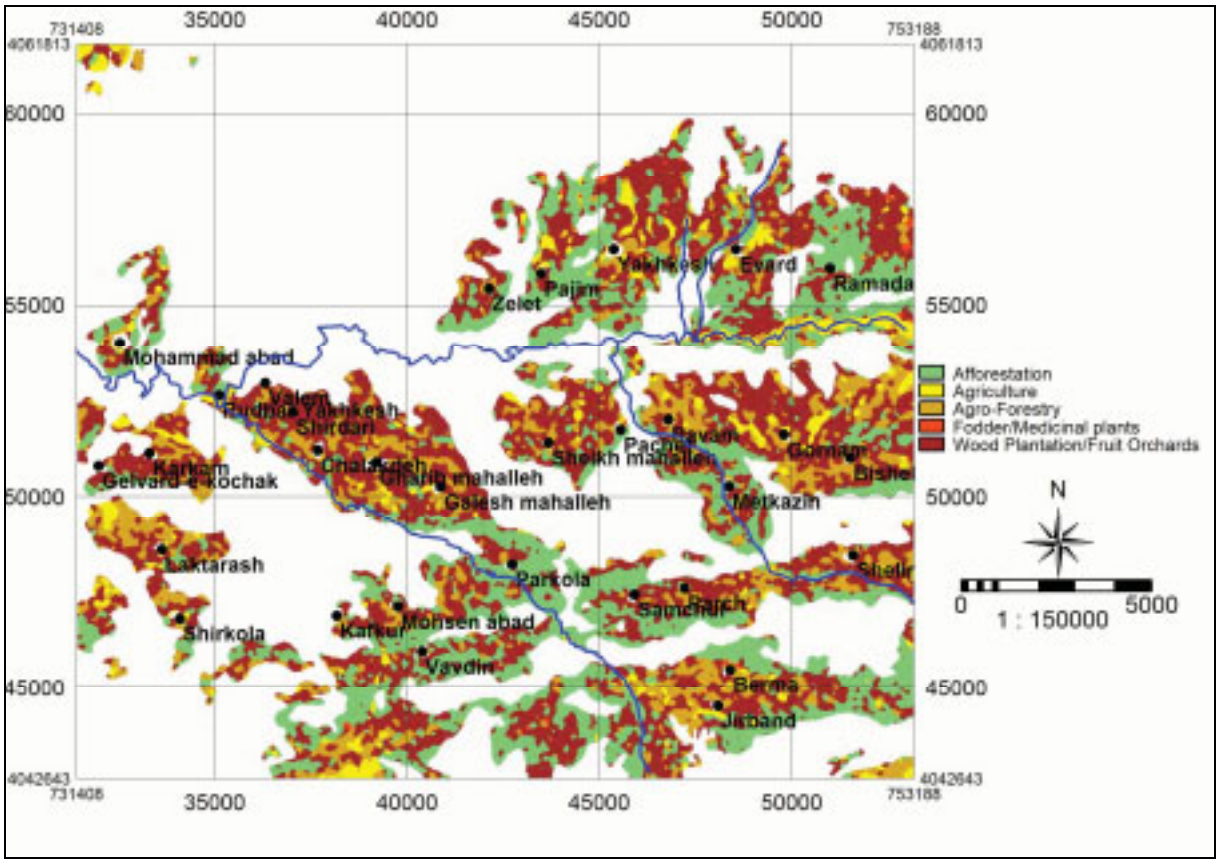
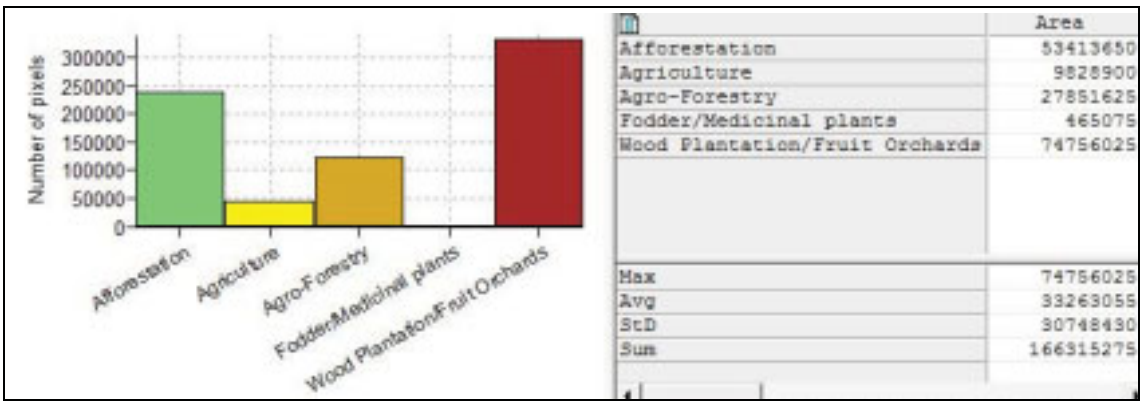


Figure 44: Final land use agreement for the current arable lands



Histogram 17: Area estimation for the suggested land use

Figure 45 and Table 11 show the discursively identified alternatives for the forest surfaces of the Yakhkesh area. The results indicate that industrial timber production and respective forest management could be done on around 13160 ha of the current forest surfaces (class 1, 2, 3 and 4 within dense forest surfaces). The other 9470 ha of the area do also show potential for such activities, but need rehabilitation of the canopy cover (class 1, 2, 3 and 4 within sparse forest surfaces). However, these areas could be suggested as domestic wood supply in a participatory manner and under supervision of FWRO.

Table 11: Suggested alternatives for suitability classes of the forest sites in the study area

Class/Density cover	Decision	Area (ha)	%
I , II, III &IV Dense	Forestry	13159,0	53,2
I,II,III & IV Sparse	Afforestation then Forestry	9469,7	38,3
V, VI &VII Dense	Preservation	966,1	3,9
V, VI & VII Sparse	Afforestation & Preservation	1156,1	4,6

The same should be aimed at concerning the 1156 ha of the forest surfaces class 5, 6 and 7 within sparse forest surfaces. Those stands also do need afforestation for strengthening their crown cover, and improving their protective functions but should be protected with respect to low forest productivity by the local FWRO. Another 966 ha of the forest surfaces in class 5, 6 and 7 do still have dense forest surfaces but should be protected for the same reasons.

A quick look on the suggested activities for farmlands and forest surfaces reveals that the re-establishment of habitat connections between fragmented forest patches could be done through reforestation in the unsuitable farmlands. Such reconnecting task may be realized through establishment of wood plantations or hedgerows within the farmland areas that have more economic attractions for the rural communities. In place of any further investigation on theoretical planning aspects, the practicability of the current planning approach needs to be tested in practice and the results need to be monitored. This is probably the best way to strengthen the participatory and transdisciplinarity discursive aspects and provide legal and administrative support mechanism. However, it needs capacity building in all related organizations for better cooperation and integrated planning and management of the natural and settled areas.

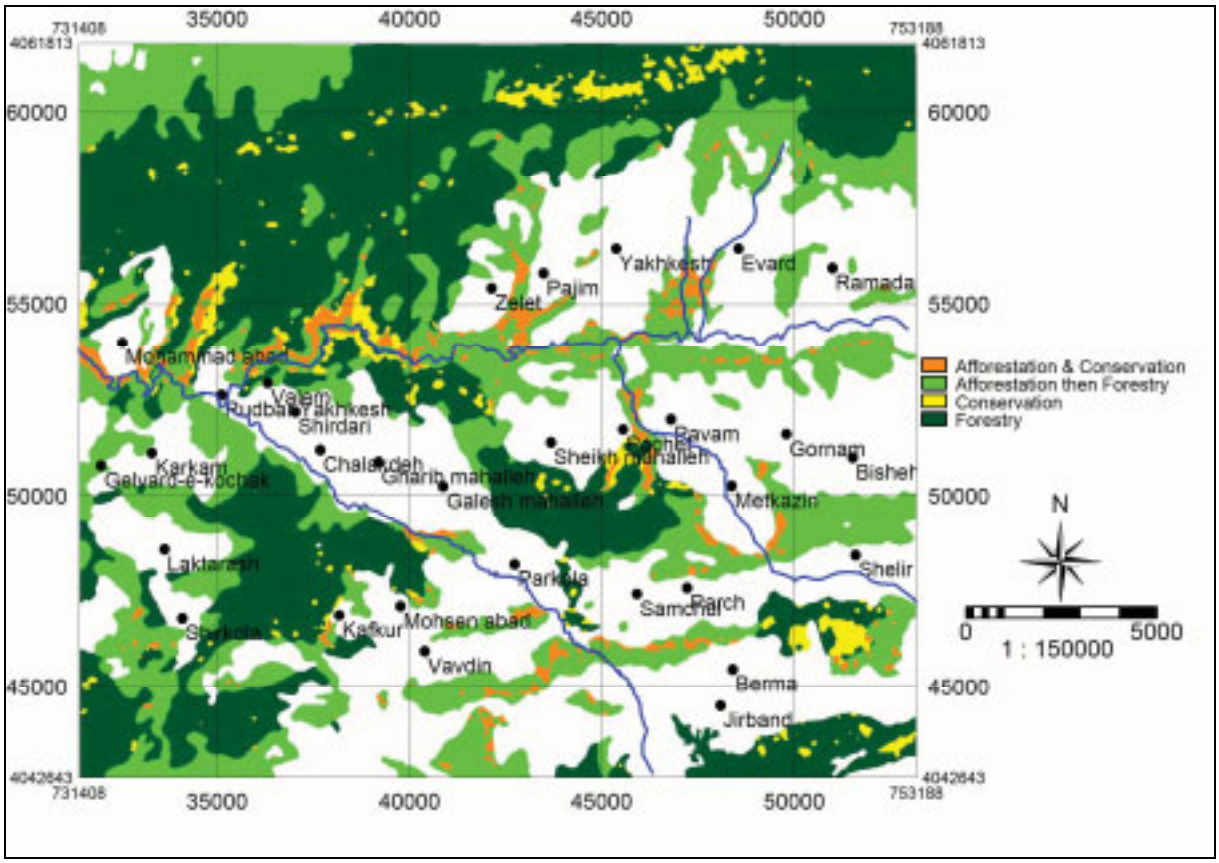
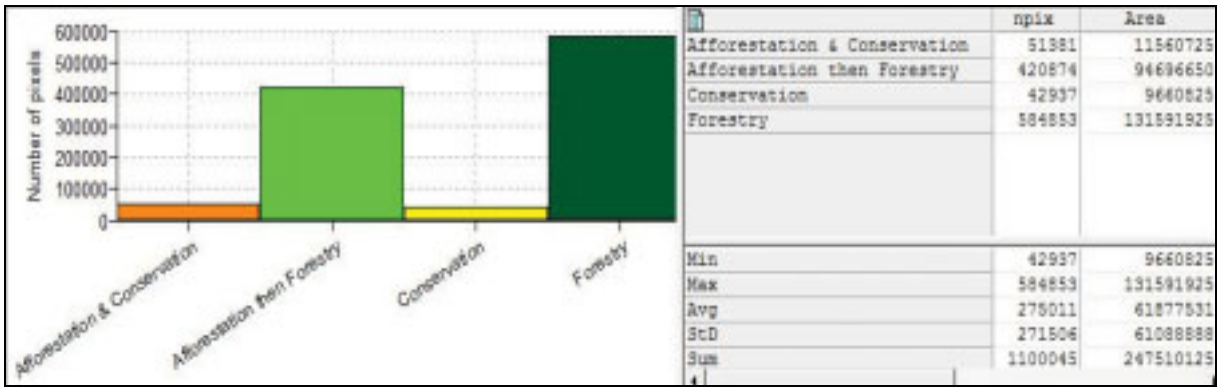


Figure 45: final land use agreement for the current forest surfaces



	npix	Area
Afforestation & Conservation	51381	11560725
Afforestation then Forestry	420874	94696650
Conservation	42937	9660825
Forestry	584853	131591925
Min	42937	9660825
Max	584853	131591925
Avg	275011	61877531
StD	271506	61088888
Sum	1100045	247510125

Histogram 18: Area estimation for forestry and afforestation in the forest surfaces of Yakhkesh

❖ A protective management approach

The third alternative is based on the results of the protective (some concepts of the German landscape planning approach) assessment approach, as an urgent response in order to slow down or prevent the destruction process in the more sensitive areas. For this, around 9071 ha (36.7%) of the forest surfaces should be designated as protective forests with respect to their high slope degree, or should be rehabilitated for strengthening their crown cover density (see

Figure 46). Around 1984 ha (21.9%) of these surfaces are situated in the vicinity of the villages, and thus especially important in reducing the risk of landslides. A special protective status is suggested for these areas in order to prevent illegal clearing, over utilization for domestic use or over-grazing. However, the basic domestic needs of the adjacent villages (especially firewood and grazing) should be estimated and then provided by the government organizations, coming from other, more remote forest areas.

It should be emphasized again, that such kind of programs could not be implemented without strong support of the affected communities. This needs related long term education, training and capacity building programs. The gradual affiliations of the forests to rural cooperative companies, based on the traditional common law territories which are still obeyed by the villagers are the best long-term strategy for a fair distribution of the forest incomes and a sustainable management of the natural resources in such areas. Although, this might lead to a decrease of some productive forests for FWRO (current forestry plans in the north of the main river), it could facilitate achieving some other important FWRO goals, e.g. protection of the soil and water in up stream and prevention of huge floods in the down-stream, which are still a big challenge regarding the socio-economic conflicts.

Regarding the agricultural land, the results of the protective assessment shows even more insistently that the great part of these areas is not ecologically suitable for agricultural activities (Figure 47). It has to be emphasized that this applies to almost the entire farmland areas, which consequently rate as potential areas for afforestation, in the ecological assessment. The major part of the appropriate agricultural surfaces however is located in the southwest of the Yakhkesh area (Figure 48). An innovative alternative could be proposed, i.e. reconciliation of forestry and agriculture by shifting the farmlands to the suitable arable lands, even though forest areas would be concerned. So far, such idea has never been discussed, because the dominant policy of the FWRO always emphasized to preserve the current forest surfaces for forestry, rather than assigning them for other land uses. However, such alternative could be further discussed on the both national and regional decision-making panels of FWRO. However, such shifting strategy needs many negotiations among all of the stakeholder groups and further co-optations.

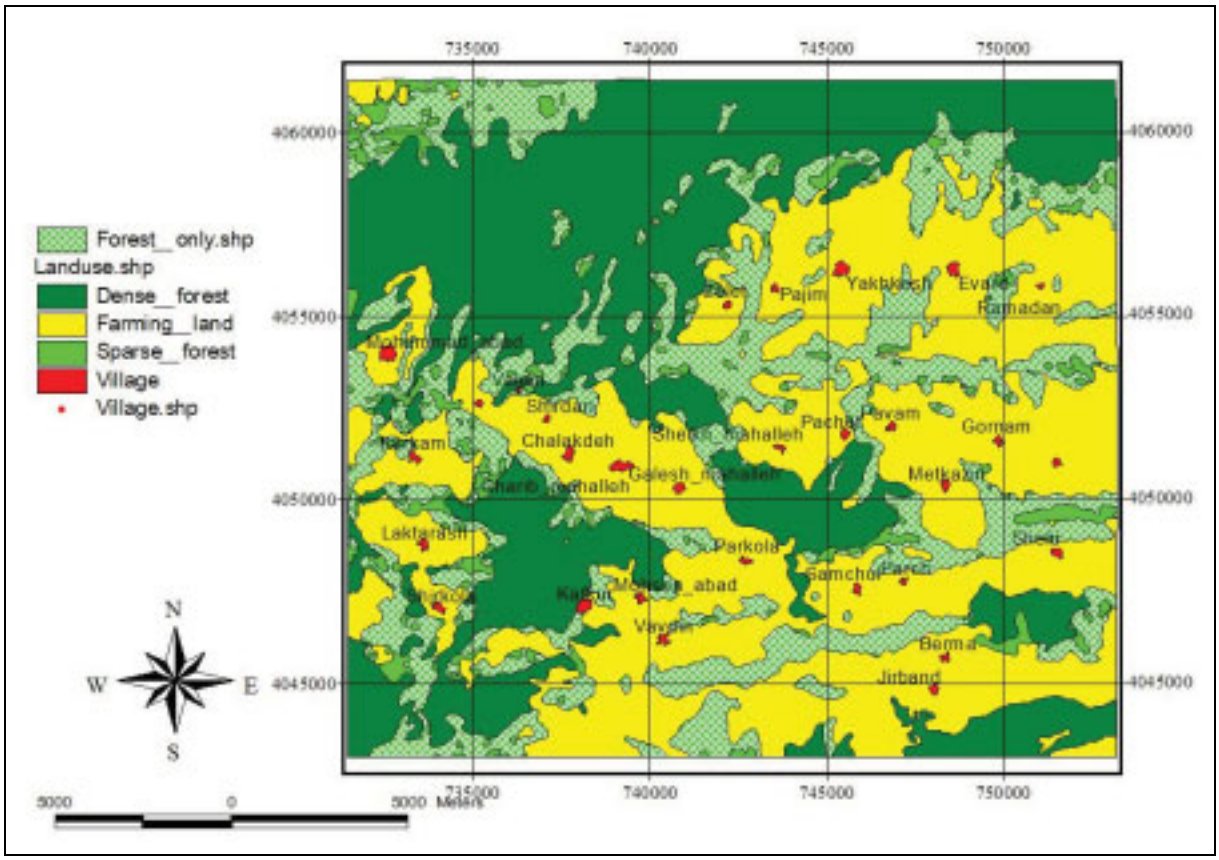


Figure 46: Suggested forest surfaces for community-based protection

These surfaces cover 978 ha (3.9%) and are represented in Figure 48. By adding the suitable surfaces within the cultivated areas, around 1510 ha (3.6%) remain for sustainable cultivation. However, with respect to the current expansion of the farmlands, this area might compensate only 9% of the total need and the difference between area requirements remains enormous. This may be solved partly by the suggested alternatives (especially agro-forestry) for the current arable lands in the integrated discursive approach (second scenario).

In spite of the innovative idea of protective forests around the villages, this alternative does not bring a socially acceptable solution for the current arable lands in the study area. However, it clearly shows that the great part of the current arable lands have to be redeveloped to their previous natural conditions as forests, if the protection of soil and water is the first main criteria for the ecological assessment.

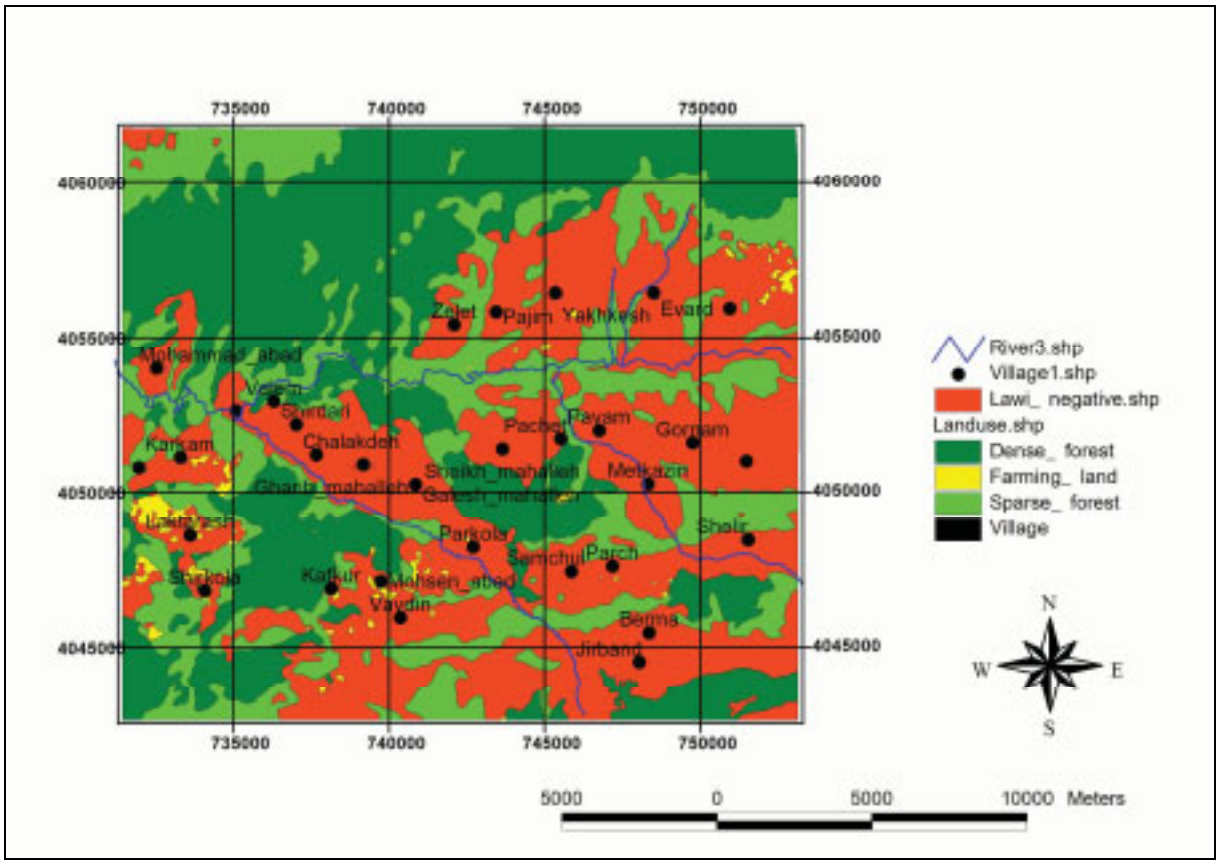


Figure 47: Unsuitable areas for agricultural activities

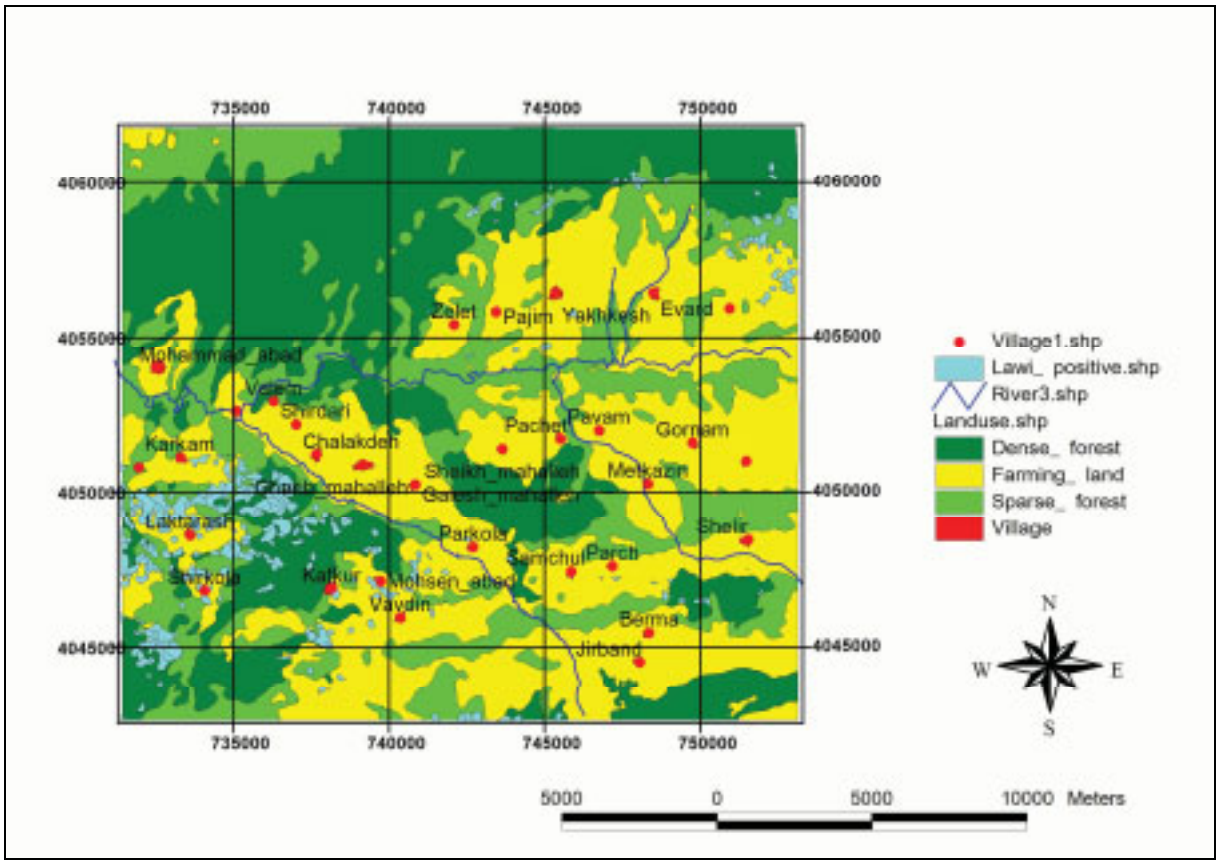


Figure 48: Suitable areas for agricultural activities, based on a protective management approach

❖ Final comparison of the discoursive and protective management approaches

Table 12 and 13 show the final comparison between the different approaches, based on the total areas of the final suggested land uses, namely forestry and agriculture. However, due to the different views and aspect of planning, the specific differences are difficult to comprehend. Some differences in area estimations originate in different processing methods, which have been used in the software environment, i.e. the raster-based analysis and data integration in ILWIS 3.4 (for the discoursive approach) and the vector-based analysis and data integration in ArcGIS9.2 environment. Furthermore, for smoothing the major land uses in the raster-based analysis, a majority filter (9*9) was used, which assigns the small areas less than filter size into the dominant surrounding land uses.

Table 12: Area estimation before and after the suggested measures in the protective approach

Land use	Before (current)		After	
	[ha]	%	[ha]	%
Yakhkesh Area	41488	100	41488	100
Total forests	24841	59,9	39979	96,4
Total Arable lands	16647	40,1	1509	3,6
Forests → Arable lands	---	---	978	3,9
Arable lands → Forests	---	---	15138	39,3
Forests → Forests	---	---	9071	36,7

Table 13: Area estimation before and after the suggested measures in the integrated (discoursive) approach

Land use	(current)		After	
	[ha]	%	[ha]	%
Yakhkesh Area	41484	100	41484	100
Total forests	24819	59,8	30160	72,7
Total Arable lands	16665	40,2	11688	27,3
Forests → Arable lands	---	---	0	0
Arable lands → Forests	---	---	5341	32,0
Forests → Forests	---	---	24819	100

In spite of area difference, it seems that the results of the discoursive approach could somehow fulfill the demands of the Government for protection of the forest areas, as well as, soil

and water. It also seems to follow the expectation and needs of the rural people by shifting their agricultural activities on the more suitable areas, while trying to increase the production yield per ha by introducing a set of new alternatives. On the other hand, the main output of the protective approach is the assignment of around 37% of the current sparse forests as protected forests, which need afforestation and protection measures, but should be preserved for protection of the rural life in the vicinity of the villages. Such aspect is always neglected in the common Iranian forestry planning process. However, the results of the both mentioned approaches lead to shift in current land uses, which in a realistic view decreases the productive forests of the Government on the one hand, and farmlands of the local peoples on the other hand, especially on those areas where the conflicts between the Government and the people are currently very high (not suitable farmlands and agriculturally-suitable sparse forests). Thus, the elaboration of such scenarios still needs further discussion and negotiation of the stakeholders on the provincial and the community levels.

We finally conclude that the discursive approach led to more ecological justified land use shift, however without expropriating the locals but transferring the bill to the Government. It should be emphasized here that most government organizations, top managers and experts do not believe in public participation or have wrong interpretations about it. It seems that the people and communities accepted their subordinated role in the top-down decision-making processes. However, people are always ready to break the rules - especially in the case of forestry and livestock management plans - when the suggested programs threaten their economic situation. On the other hand, the experience and knowledge of the staff, who are conducting these operational programs, seem to be the key factors for their successful implementation of these programs (Nouri, 1999). However, the lack of democracy accompanied by low levels of education and income, created a huge difference between the rural societies and the governmental staffs. In fact, people can hardly rely on the government staffs, and vice versa. It seems that the rural society needs long term financial supports as well as education and training programs to remain active and eager for participation. However, this process could be accelerated by the establishment and strengthening of multi-purpose rural cooperatives, improvement of the transport and other infrastructure, fossil fuel supply, distribution of agricultural goods (multi-purpose investments), assigning of green taxes, implementation of demonstration projects and introducing new livelihood alternatives to increase the total production and income.

It seems that the best long term alternative with respect to ecology, people's livelihood and wealth and final costs for the Government would be the "community forestry". In fact, the traditional knowledge and the ancient rural management system have great potentials for nearly all kind of community-based activities, i.e. forestry, watershed management, grassland management, agriculture and animal husbandry. However, the society as well as the government has shown little efforts for mutual and win-win cooperation. Our interviews with the both local experts and people show that they are eager for cooperation if their knowledge, experiences and desires are not neglected or even miss-used. The same idea also came from projects like FAO (1999) in adjacent areas and the UNDP-GEF small project (2000-2005) in Yakhkesh (see Picture 20). The results of the UNDP project show that even a small team of knowledgeable experts can make a huge change in the public confidence towards sustainable and wise utilization of their resources for a better life. For example, villagers in the UNDP project areas could increase the total wheat production from 1 to 3 tons/ha, while people in adjacent areas still harvest up to 0.8 ton/ha. In company with other new alternatives like cultivation of medicinal plants or fodder crops, the total income of the villagers might be increased up to 200% or even more, without any increase of the cultivated land (see table 14). Furthermore, the total cultivation capacity of the Yakhkesh area could be easily increased from the current 6700 ha of the active farmlands to 9000 ha or more by using the fallow lands and introducing multi-purpose farming techniques. By introducing the Agro-forestry on the sloppy farmlands it is possible to increase the total production of fodder crops from 10500 to above 17100 tons per annum (UNDP-GEF, 2004). The same increase in total production of the cereals is also possible form 7550 ton to 12200 tons per annum by means of the genetically improved races as well as by modernization of the traditional cultivation system. The MOAC estimation shows that the total production of the poplar (*Populus persica*) and other fast-growing trees could reach 1.8 ton per ha per annum and the total areas of the gardens and orchards could be increased to 730 ha with a total production of 3000 tons per ha per annum.

In fact, such mountainous areas have a great potential for semi-intensive cattle raising, which greatly matches with the socio-economic needs and culture of the rural society, while can easily use the outputs of the agro-forestry activities for producing meat and dairy products. The results of the UNDP-GEF show the huge economic profits of the new alternative livelihoods compared to the traditional ones. In addition to the income increase, these activities could decrease the high unemployment and migration rates of the younger generations and produce new jobs, even for youth and women.

Table 14: Area estimation before and after the suggested measures in discursive approach

Cultivation	Total production (Tons/ha/year)	Estimation of income $US
Wheat (dominant cultivation)	1	152.3
Poplar	6.5	495.1
Alfalfa	3.1	405.9
Borage (Medicinal plant)	0.6	326.4

However, the results of such demonstration projects can easily get lost or forgotten without future supports, training, and monitoring by the government organizations. Regarding forest protection and timber extraction, it should be emphasized again that the local people are the only eligible groups, who should undertake the management and utilization task of their surrounding forests. Nevertheless, this should be promoted and supported by the governmental organizations, mainly FWRO for a long period till the rural society be able to completely undertake the task.

❖ Opportunities for cooperation

Undoubtedly, the useful implementation of a holistic multi-purpose plan needs a proper *integrated strategy*, which is understood and accepted by all stakeholders. A quick look on the current programs and on the institutional context reveals that there are indeed many options for cooperation. Figure 49 represents a sample of such inter-sectoral cooperation opportunities with respect to the current programs in different sectors. In fact, an integrated plan could conduct, harmonize and thus increase the efficiency of the different sectoral programs, while decreasing the budget, time and other possible challenges among stakeholders on the government as well as on the community levels.

❖ A bundle of appropriate strategies

The suggested approaches and their related scenarios might be discussed according to their strategic orientation, which could be “protective”, “defensive”, “offensive” or “opportunistic” (Ahern 1995). These strategies, in essence, define the planning context with respect to the macro - drivers of change in a given landscape and the strategic nature of the planners’

Picture 20: Some of the suggested activities in the UNDP-GEF project. Above left, the Bio-gas cell for a public bath in Pachat village. Above middle/left: a semi-intensive animal husbandry station. Middle: cultivation of borage as medicinal plant creates income and new jobs for the women and youth. Below-left: cultivation of the poplar and alfalfa. Middle: a local nursery for the needed sapling. Right: participation of the rural community in reforestation of the degraded forests.

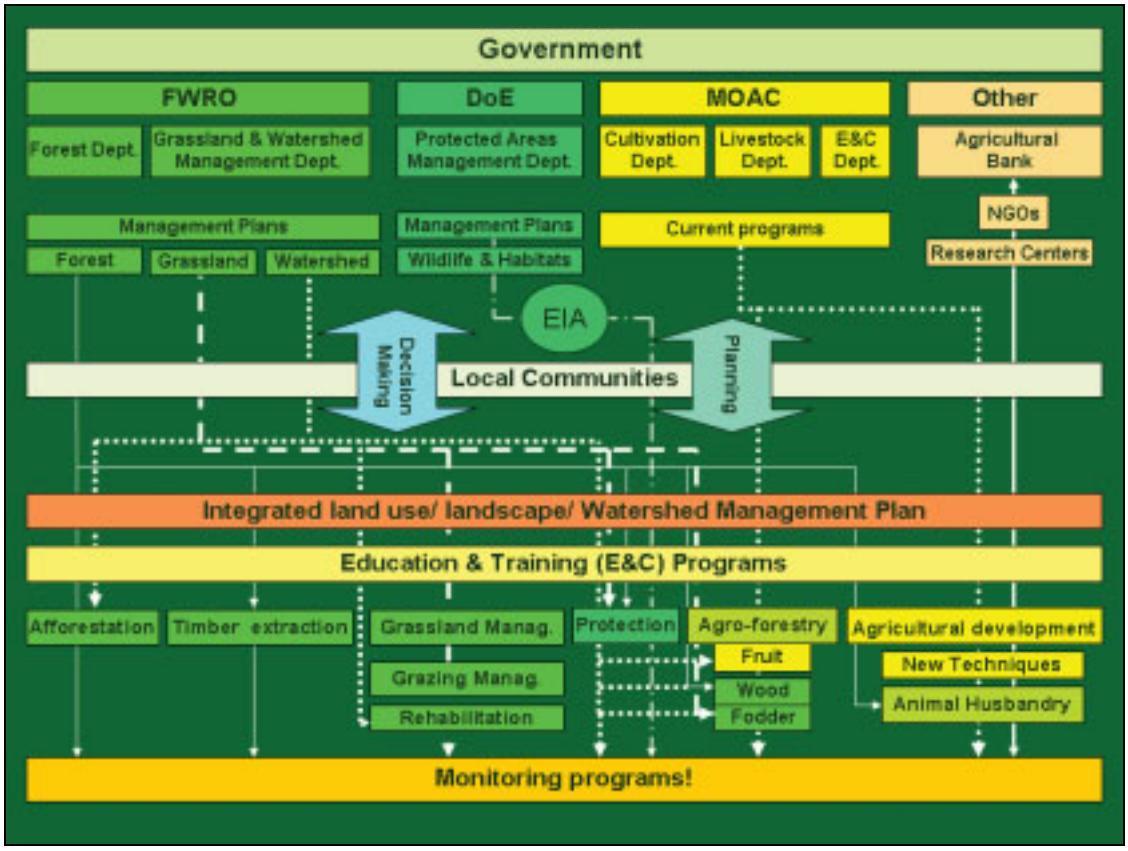


Figure 49: Current sector development programs could be properly integrated in a holistic manner. The arrows show the possible contributions of each stakeholder, including government organizations and local communities.

response: if the landscape still does support sustainable processes and patterns, a protective strategy may be employed. This is what has been considered in both scenarios for the forest surfaces and agricultural areas which have the best ecological conditions for the suggested activities. Essentially, this strategy defines an "optimal pattern" that is proactively protected from undesired impacts and changes while the landscape around may be allowed to change. For fragmented forest areas, a *defensive strategy* should be applied. Using this strategy, we seek to arrest or control the negative processes of fragmentation in those forest areas which are threatened by the land conversion. As a last resort, the defensive strategy is often necessary, but it can also be seen as a reactionary strategy which attempts to 'catch up with' or 'put on the brakes', against the inevitable process of landscape change, in defense of an ever-decreasing nature (Sijmons 1990). The suggested afforestation and fodder cultivation activities comprise the *offensive aspect* of the suggested plans. The offensive strategy employs restoration, or reconstruction, to re-build landscape elements in previously disturbed or fragmented landscapes. The offensive strategy relies on planning knowledge, knowledge about ecological restoration, and it needs a significant public support or funding. The offensive strategy essentially involves 'reintroducing nature' into the landscape, according to an accepted vision or plan. However, as it was mentioned by Ahern (1995), it is only rarely practiced because it is expensive and often politically sensitive. Finally, we also used an *opportunistic strategy* to recognize the special opportunities in order to add other functions to them and to enable future landscape configurations to support ecological or cultural processes. This was considered by suggesting the agro-forestry activities for protection of the soil and water and to increase the income levels from timber, fruit and fodder cultivation on the sloppy farmlands.

The *spatial concepts* are another important aspect, which should be highly imaginable and understandable by the public, but can also support and inspire the planning process (Zonneveld 1991). It seems that the results of the improved Iranian approach, especially in suggesting more sustainable alternatives for the current farmlands, provide a better spatial concept for agricultural activities, while the second scenario provides a better spatial concept for establishment or strengthening the protective forest areas for protecting soil, water and habitats and preventing flood or landslides from an ecological point of view.

Finally, stakeholder *participation* in all phases of the planning process, i.e. in the assessment phase, in the search for alternatives and in the developing of the scenarios, as well as in the subsequent implementation phase could improve the transdiciplinarity level of the current Iranian approach. Apart from public participation, which is certainly a key factor in the trans-

disciplinary planning, the suggested plan needs to be monitored to reveal its advantages and weaknesses and to further improve its success. This is still quite rare in Iran, especially on the local scale.

Regarding the technical aspects of the planning process and reliability of the results, following issues need to be considered:

i) there is a huge need on standardizing comprehensible methods for aggregating and generalizing the data and assessment of the final results

ii) Acceptable levels of accuracy for both input and output data should be defined for all planning levels (national, regional and local)

iii) Methods should be developed for both quality and accuracy assessment of the final plans

iv) Standard assessment models should also be developed for the main eco-regions of Iran

CHAPTER VII

CONCLUSIVE SUMMARY

The lack of an efficient environmental planning and management system has always been considered as a basic problem towards achieving sustainable development in the Caspian Region, North of Iran. The Caspian forests are a globally and nationally important source of Biodiversity, which face numerous threats. During the past decades, the narrow economic base in the mountainous areas and the very limited opportunities for income generation, as well as increasing population pressures led to over utilization of the natural resources by the rural communities. Additionally, a lack of monitoring and of public participation in forestry as well as in other planning sectors increased illegal activities and over-utilization of the natural resources by private enterprises and local people. Soil erosion, accompanied by destructive floods and declining fertility as well as productivity, resulted in severe degradation of natural habitats with negative socio-economic consequences. It is clear that the future development of the region should be conducted in a sustainable manner, in which environmental conservation and protection goals can be achieved in company with socio-economic needs of the society. Since 1980, an environment-based land use planning has been developed from an analogue process to a semi-automated one in which, GIS software and Remote Sensing techniques are used, not only to increase the speed but also the accuracy of the planning process. Although, it has been successfully used as a guideline for spatial planning on both national and regional levels, it could not bring efficient and practical solutions on the local scale. This may partly be caused by legal and administrative constraints, but it also results – to a large extend – from a purely top-down procedure, which does not facilitate an active participation among all stakeholders in both, planning and implementation phases. As this is the best available national planning system, which has been developed so far, all of the efforts should be focused on the enhancement and improvement of its capabilities by identifying and then removing its weaknesses. This study intended to present an analysis of the landscape management problem in order to detect the immediate and underlying threats to the sustainable utilization of the natural resources, esp. forests, in Yakhkesh Mountains as a sample area of the Caspian mountainous ecosystem. Using questionnaire method, a community (socio-economic) assessment was conducted to gain the ideas and comments of the villagers and local/national experts about the current management system, its weaknesses and possible solutions to prevent negative social as well as ecological consequences of the forest loss. After collecting and processing the available ecological and socio-economic data, a GIS-based ecological assessment was made using a discursive (Iranian approach) and protective (some concepts of the German approach for landscape planning). Some scenarios were developed based on the experiences and results of the past and recent national and international projects across

the region. The draft plans were then assessed by both villagers and Iranian experts to finalize the planning scenario. The results revealed that there are many possible solutions to overcome the mentioned problems, which could be presented in an integrated management plan with close cooperation of the all stakeholders. Therefore, an operational mechanism is suggested to use the current development programs in an integrated manner. Although, access to the detailed and up to date data is still a main problem, the available ecological and socio-economic data could be more efficiently used for a participatory nature conservation and landscape management in Iran. This process could be improved through "learn by doing", which again shows the importance of the implementation and monitoring of the plans that unfortunately remain as a big problem in Iran.

According to the goals and objectives of the study, following remarks could be mentioned:

1. This study intended to do a root-cause analysis of the forest loss by considering all of the immediate and underlying threats (see Figure 29, chapter V). This is done by reviewing all of the available studies and related projects to find the so-called root-causes and then be examined through field visits and interviews with the both local villagers, as well as, the experts on community, regional and national levels. By considering the forest loss, as a multi-dimensional problems, we tried to detect the first, second and even third underlying causes and to track the vertical and horizontal relationships of the important reasons, which then could be used for developing the possible solutions as an integrated management plan. The results were also proved by the local and national experts and in some degree by the local people.

2. Regarding the suggested approach, this study could introduce a more realistic manner than the common Iranian approach, not so much with respect to the data processing procedure, but more with respect to simplifying the assessment models, the level of community participation in decision-making and also by adding some nature conservation aspects (i.e. distance to rivers and creeks). This approach might be even more efficient than the current planning procedures, especially regarding forest protection and flood prevention, by delineating the ecologically sensitive areas and could bring more sustainable and socially-acceptable solutions than the current "fence and guard" strategy of the Governmental organizations. The results of the community assessments show that even local staffs of the responsible organizations could not bring their ideas and comments to improve the current planning procedures for natural resources management, while the top-managers and decision-makers still continue ignoring the social needs of the rural societies. The so-called top-down planning and management ap-

proach could not bring either sustainable solution for the people nor could protect forests and grasslands from over-utilizations and illegal activities, especially in remote areas like Yakhkesh. The suggested operational mechanism (see Figure 49) is in fact a call for integrated planning, even using the current governmental programs in the related sectors, which could conduct the tasks to the suitable areas for agriculture, forestry, afforestation and nature conservation and could prohibit task overlays as well as wasting time and money.

3. This study also intended to demonstrate the tremendous potential for similar integrated community-based management approaches for the protection and sustainable use of other important forest ecosystems in the Caspian region, Northern Iran. In fact, one of the basic hypothesis was that a more intensive and efficient agricultural use of the farmlands (plus additional goods like fruit, fodder, medicinal plants, fuel wood etc.) would be able to nourish the same amount of people on less area and decrease the anthropogenic pressures on the forests. Such desire for participatory approaches is also approved by the community assessment of the suggested alternatives. Furthermore, if the suggested alternatives could be properly promoted in capable areas (e.g. agro forestry or cultivation suitable areas), it could increase the total production and income of the rural society, as well. A quick look at the different incomes form the UNDP-GEF project proved such idea. In fact, the main problem of the all previous national and international projects (mainly FAO and GEF) to promote the mentioned alternatives was the lack of a realistic integrated plan, which could show the suitable areas in a systematic manner. Actually, all of these plans have been implemented by only focusing on getting more volunteers than finding the suitable areas for their suggested activities.

4. One of the main goals of this study was to investigate local scale planning, which however could not be properly done, due to the lack of detailed information and needed data layers on a scale larger than 1:25000. In fact, most of the collected or produced spatial data had to be resampling from a smaller scale, due to the rather limited budget and time for this study. However, the results show that the available data might be used for an integrated and discursive planning approach, which is an urgent need for the prevention of the environmental and socio-economic damages in the mountain forests of the Caspian Region. It should be emphasized that for achieving a true adaptive planning method, we should accept a certain level of uncertainty and risk, maintains a commitment to monitoring, and perhaps most importantly will to fail. Although adaptive management has been practiced in resource management for at least two decades, it has not yet been widely integrated into planning.

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APPENDICES

Appendix I

The List of the important animal species in Yakhkesh area (Provincial DoE and MOAC 2000, UNDP-GEF project 2002-2006, Field visits & Interviews 2005-2007)

No.	English name	Scientific Name	Biodiversity importance	Source of information
Mammals				
1	Red deer	Cervus elaphus	IUCN/DoE red list	DoE Behshahr, Local hunters
2	Roe buck	Capreolus capreolus	IUCN/DoE red list	DoE Behshahr, Local hunters
3	Bear	Ursus arctos	DoE protected sp.	DoE Behshahr, Local hunters & Pastoralists
4	Wolf	Canis lupus	DoE protected sp.	DoE Behshahr, Local hunters & Pastoralists
5	Lynx	Lynx lynx	IUCN/DoE red list	DoE Behshahr, Local hunters & Pastoralists
6	Leopard	Panthera pardus	DoE protected sp.	DoE Behshahr, Local hunters & Pastoralists
7	Otter	Luthra luthra	IUCN/DoE red list	DoE Behshahr, Local hunters
8	Bat		IUCN/DoE red list	
Birds				
8	Pheasant	Phasianus colchicus	IUCN/DoE red list	DoE Behshahr, Local hunters
9	Chukar Partridge	Alectoris chukar	DoE protected sp.	DoE Behshahr, Local hunters
10	Sparrow Hawk	Accipiter nisus	IUCN/DoE red list	DoE Behshahr, Local hunters
11	Buzzard	Buteo buteo	IUCN/DoE red list	DoE Behshahr, Local hunters
12	Lesser Spotted Eagle	Aquila pomarina	IUCN/DoE red list	DoE Behshahr, Local hunters
13	Egyptian Vulture	Neophron prenopterus	DoE protected sp.	DoE Behshahr, Local people
14	Griffon Vulture	Gyps fulvus	DoE protected sp.	DoE Behshahr, Local people
15	Peregrine Falcon	Falco peregrinus	DoE protected sp.	DoE Behshahr, Local hunters
16	Kestrel	Falco tinnunculus	DoE protected sp.	DoE Behshahr, Local hunters
17	Green Woodpecker	Picus viridis	DoE protected sp.	DoE Behshahr, Local people
18	Black woodpecker	Dryocopus maritus	DoE protected sp.	DoE Behshahr, Local people
19	Eagle Owl	Bubo Bubo	DoE protected sp.	DoE Behshahr, Local people
20	Tawny Owl	Strix aluco	DoE protected sp.	DoE Behshahr, Local people
Fish				
21	Salmon fish	Salmo trout caspicus	IUCN/DoE red list	Hiltscher, Geottingen University

Appendix II

The List of Biodiversity important plant species in Yakhkesh area (Sabeti 1976, MAOJ 2000)

No	English name	Scientific Name	Biodiversity importance	Source of information
	Trees & Shrubs			
1	Yew	Taxus baccata	IUCN red list	*Sabeti, 1976, MOAC 2000
2	Box tree	Boxus hyrcana	IUCN red list	Sabeti, 1976, MOAC 2000
3	Caspian poplar	Populus caspica	IUCN red list	Sabeti, 1976, MOAC 2000
4	Walnut	Juglans regia	IUCN red list	Sabeti, 1976, MOAC 2000
5	Siberian elm	Zelkova crennata	FRO list of genetic resources	Sabeti, 1976, MOAC 2000
6	Wych elm	Ulmus glabra	FRO list of genetic resources	Sabeti, 1976, MOAC 2000
7	Common elm	Ulmus carpinifolia	FRO list of genetic resources	Sabeti, 1976, MOAC 2000
8	Caucasian Oak	Quercus castaneifolia	FRO list of genetic resources	Sabeti, 1976, MOAC 2000
9	Pear tree	Pyrus communis	FRO list of genetic resources	Sabeti, 1976, MOAC 2000
10	Wild cherry	Prunus avium	FRO list of genetic resources	Sabeti, 1976, MOAC 2000
11	Service tree	Sorbus torminalis	FRO list of genetic resources	Sabeti, 1976, MOAC 2000
12	Ash	Fraxinus excelsior subsp. cariarifolia	FRO list of genetic resources	Sabeti, 1976, MOAC 2000
13	Quince tree	Cydonia oblonga	IUCN red list	Sabeti, 1976, MOAC 2000
14	Alder buck-thorn(Dog-wood)	Rhamnus frangula	IUCN red list	Sabeti, 1976, MOAC, 2000
	Herb species			
15	Great Burdock	Arctium lappa	IUCN red list	MOAC, 2003
16	Hops (wild hop)	Humulus lupulus	IUCN red list	MOAC, 2003
17	Winter cherry	Physalis alkekengi	IUCN red list	MOAC, 2003
18	?	Digitalis nervosa	IUCN red list	RIFRI, 2000
19	?	Danae racemosa	IUCN red list	RIFRI, 2000
20	?	Dianthus rudbaricus	IUCN red list	RIFRI, 2000
21	?	Anthemis gilanica	IUCN red list	RIFRI, 2000
22	?	Crucus almehensis	IUCN red list	RIFRI, 2000
23	?	Dracocephalum kotschyii	IUCN red list	RIFRI, 2000
24	?	Satureja isophylla	IUCN red list	RIFRI, 2000
25	?	Satureja intermedia	IUCN red list	RIFRI, 2000
26	?	Lilium lidebourii	IUCN red list	RIFRI, 2000
27	?	Polygonatum polyan-themum	IUCN red list	RIFRI, 2000

Appendix III

Linear Ecological Capability Assessment Models of Iran for Forestry and afforestation, agricultural actitivities and ecological preservation (Makhdoum, 2002)

1- Forestry (Fn) and afforestation (Fp):

- F1= E(1,2,3,4,5)+S0 (1,2,3,4,5,6,7)+Cp(5,6,7)+Ct(2) + Ch(2,3,4) + Li(2,7)+Pte(8,9,11,12)+Ph(1,2)+Es(1,2)+Ps1(1)+Pg(1,2)+ Pd(1,2) + Ps2(1)+Pf(1)+ Pdr(1)+Phg(3)+Vgo(1)+ Ino(1,2)+ Si(7)+Bvc(1,2)+H(10)+Pr(13)+Vf(1,2,3,4,5)
- F2= E(1,2,3,4,5)+S0 (1,2,3,4,5,6,7)+Cp(5,6,7)+Ct(2) + Ch(2,3,4) + Li(2,3,7,10,12)+Pte(8,9,11,12)+Ph(1,2)+Es(1,2)+Ps1 (1)+Pg(1,2) +Pd(1,2,3)+Ps2(1)+Pf(1,2)+ Pdr(1,2)+Phg(3)+Vgo(1)+ Ino(1,2,3)+ Si(7)+Bvc(1,2)+H(10)+Pr(13)+Vf(1,2,3,4,5)
- F3= E(1,2,3,4,5,6,7,8)+S0 (1,2,3,4,5,6,7,8)+Cp(4,5,6,7)+Ct(1,2,3,4) + Ch(2,3,4) + Li(2,3,5,7,10,12)+ Pte(4,8,9,10,11,12) +Ph(1,2,3)+ Es(1,2) +Ps1 (1)+Pg(1,2,3) +Pd(1,2,3)+Ps2(1)+Pf(1,2,3)+ Pdr(1,2,3)+Phg(2,3)+Vgo(1,2)+ Ino(1,2,3,4)+ Si(7)+Bvc(1,2)+H(10)+ Pr(13) +Vf(1,2,3,4,5)
- F4(n)= E(1,2,3,4,5,6,7)+S0 (1,2,3,4,5,6,7,8,9)+Cp(4,5,6,7)+Ct(1,2,3,4) + Ch(2,3,4) + Li(2,3,4,5,7,8,10,12,16)+ Pte(1,2,3,4,5,6,7,8,9,10 11,12) + Ph(1,2,3)+ Es(1,2,3) +Ps1 (2,3)+Pg(1,2,3,4)+ Pd(2,3,4)+Ps2(1,2)+Pf(3,4)+ Pdr(3)+Phg(1,2,3)+Vgo(3)+ Ino(5,6)+ Si(7)+ Bvc(3) +H(10)+ Pr(13) +Vf(1,2,3,4,5)
- F4(p)= E(1,2,3,4,5,6,7)+S0 (1,2,3,4,5,6,7,8,9)+Cp(2,3,4,5,6,7)+Ct(1,2,3,4,5) + Ch(2,3,4) + Li(1,2,3,5,6,7,8,10,11,12,14,16,17)+ Pte(1,2,3,4,5,6,7,8,9,10,11,12) + Ph(1,2,3,4)+ dsm(1,2)+Es(1,2,3,4) +Ps1 (1,2,3)+Pg(1,2,3,4)+ Pd(1,2,3,4)+Ps2(1,2,3)+Pf(1,2,3)+ Pdr(1,2,3) +Phg(1,2,3,4) (pre-afforestation)+Vgo(4,5,6)+ [Vgo(1,2,3,4,5,6)] (after afforestation)+ In1[1(F4P1),2(F4P2),3(F4P3), 4(F4P4)] + Si(5,6,7,8)+ Bvc(3) +H(2,4,8,10,12)+ Pr(3,13) +El(3,4,5)+Vf(1,2,3,4,5) + H1(1,2,3)
- F5= E(6,7,8)+S0 (1,2,3,4,5,6,7,8,9,10)+Cp(3,4,5,6,7)+Ct(1,2,3,4,5) + Ch(1,2,3,4) + Li(1,2,3,4,5,7,8,10,11,12,14,16,17)+ Pte(1,2,3,4,5,6,7,8, 9,10 11,12,13) + Ph(1,2,3,4)+ Es(1,2,3,4,5) +Ps1 (1,2,3,4)+Pg(1,2,3,4)+ Pd(3,4)+Ps2(1,2,3,4)+Pf(4)+ Pdr(3,4,5)+Phg(1,2,3,4)+Vgo(3,4) + Ino(6,7,8)+ Si(7)+ Bvc(3) +H(10)+ Pr(13) +Vf(1,2,3,4,5)
- F6= E(1,2,3,4,5,6,7,8,9)+S0 (1,2,3,4,5,6,7,8,9,10)+Cp(3,4,5,6,7)+Ct(1,2,3,4,5) + Ch(1,2,3,4) + Li(1,2,3,4,5,6,7,8,10,11,12,13, 14,16,17)+ Pte(1,2,3,4,5,6,7,8, 9,10 11,12,13) + Ph(1,2,3,4)+ dsm(1,2,3)+Es(1,2,3,4,5,6) +Ps1 (1,2,3,4)+Pg(1,2,3,4)+ Pd(4,5)+Ps2(1,2,3,4)+Pf(5)+ Pdr(4,5)+Phg(1,2,3,4)+Vgo(3,4,5) + Ino(7,8)+ Si(7)+ Bvc(3) +H(10)+ Pr(13) +Vf(1,2,3,4,5)
- F7= E(1,2,3,4,5,6,7,8,9)+S0 (8,9,10)+Cp(3,4,5,6,7)+Ct(1,2,3,4,5) + Ch(1,2,3,4) + Li(1,2,3,4,5,6,7,8,10,11,12,13,14,16,17)+ Pte(13) + Ph(1,2,3,4)+ Es(1,2,3,4,5,6,7) +Ps1 (1,2,3,4)+Pg(4)+ Pd(5)+Ps2(3,4)+Pf(5)+ Pdr(5)+Phg(1,2,3,4)+Vgo(4,5,6) + Ino(7,8)+ Si(7)+ Bvc(3) +H(10)+ Pr(13) +Vf(1,2,3,4,5)

2- Agricultural activities [irrigated farming(I) , animal husbandry (CH), agricultural industries (AI), poultry production (P), Apiculture (B), silkworm culture (CA), horticulture (H), rain-fed farming (DF)]and range management (Ra):

- AR1(I-CH-I-P-B-CA-H)= Cl[cd(4,5,6,7,8)]+Wc(1,2)+So(1,2)+Ct(2,3,4)+Ch(2,3,4)+ dsm(1,2)+Es(1,2)+Ps1(1)+Ph(2)+Pg(1,2) +Pd(1) +Ps2(1) +Pf(1)+Pdr(1)+Phg(1,2)+Pte(7,8,10,12)+H(10)+Pr(13)+Cvt(3)+Ha(2,3)+Si(5,8)
- AR2(I-CH-AI-P-B-CA-H)= Cl[bcd(3,4,5,6,7,8)]+Wc(1,2,3)+So(1,2,3)+Ct(1,2,3,4)+Ch(2,3,4)+ dsm(1,2)+Es(1,2)+Ps1(1) +Ph(2,3)+ Pg(1,2,3) +Pd(1,2,3)+Ps2(1) +Pf(1,2)+Pdr(1,2)+Phg(1,2)+Pte(4,7,8,9,10,12)+H(10)+Pr(13)+Cvt(3)+Ha(2,3)+Si(5,8)
- AR3(I-CH-AI-P-B-CA-H)= Cl[abcd(2,3,4,5,6,7,8)]+Wc(1,2,3)+So(1,2,3)+Ct(1,2,3,4,5)+Ch(1,2,3,4)+ dsm(1,2,3)+Es(1,2)+Ps1(1,2) +Ph(1,2,3)+ Pg(3,4) +Pd(2,3,4)+Ps2(1,2,3) +Pf(2,3,4)+Pdr(1,2,3,4)+Phg(1,2,3)+Pte(1,2,3,4,5,6,7,8,9,10,11,12) +H(10)+Pr(13)+Cvt(3) +Ha(2,3)+ Si(5,8)
- AR4(DF-H-CH-AI-P-B-CA)= Cl[bcd(3,4,5,6,7,8)]+Wc(4)+So(1,2,3,4)+Ct(2,3,4,5)+Ch(2,3,4)+ Cp(4,5,6,7)+dsm(1,2)+Es(1,2)+ Ps1(1,2) +Ph(1,2)+ Pg(1,2,3) +Pd(1,2,3)+Ps2(1,2) +Pf(1,2,3)+Pdr(1,2)+Phg(1,2)+Pte(4,7,8,10,12) +H(10)+Pr(13)+Cvt(3) +Ha(2,3)+ Si(5,8)
- R4[Ra]= Cl[abcd(2,3,4,5,6,7,8)]+Wc(4)+So(1,2,3,4,5)+Ct(1,2,3,4)+Ch(1,2,3,4)+ Cp(4,5,6,7)+dsm(1,2)+Es(1,2)+ Ps1(1,2,3) +Ph(1,2,3)+ Pg(1,2,3,4) +Pd(1,2,3,4)+Ps2(1,2) +Pf(1,2,3)+Pdr(1,2)+Phg(1,2)+Pte(1,2,3,4,5,6,7,8,9,10,11,12) +H(10)+Pr(8,13)+Dg(1)+Ba(4,5)+ Vg(1)+Rac(1,2,3)+Vf(1,2,3)+ Si(5,8)+Cvt(3) +Ha(2,3)+Rc(1,2)
- AR5(DF-H-CH-AI-P-B-CA)= Cl[abcd(2,3,4,5,6,7,8)]+Wc(4)+So(1,2,3,4)+Ct(1,2,3,4,5)+Ch(1,2,3,4)+ Cp(3,4,5,6,7)+dsm(1,2,3)+ Es(1,2,3) + Ps1(1,2,3) +Ph(1,2,3)+ Pg(3,4) +Pd(3,4)+Ps2(1,2,3) +Pf(2,3,4)+Pdr(3,4)+Phg(1,2,3)+Pte(1,2,3,4,5,6,7,8,9,10,11,12) + H(10) +Pr(13)+ Cvt(3) +Ha(2,3) +Si(5,8)
- R5[Ra]= Cl[abcd(2,3,4,5,6,7,8)]+Wc(4)+So(1,2,3,4,5)+Ct(1,2,3,4,5)+Ch(1,2,3,4)+ Cp(3,4,5,6,7)+dsm(1,2,3)+Es(1,2,3)+ Ps1(1,2,3) +Ph(1,2,3)+ Pg(3,4) +Pd(3,4)+Ps2(1,2,3) +Pf(2,3,4)+Pdr(3,4)+Phg(1,2,3)+Pte(1,2,3,4,5,6,7,8,9,10,11,12) +H(10)+Pr(8,13)+Dg(2)+ Ba(3,4,5) + Rac(3,4)+Vgo(2)+Vf(1,2,3)+ Si(5,7,8)+Cvt(3) +Ha(2,3,4)+Rc(3,4)
- R6 [Ra]= Cl[abcd(1,2,3,4,5,6,7,8)]+Wc(4)+So(5,6,7,8)+Ct(1,2,3,4,5)+Ch(1,2,3,4)+ Cp(2,3,4,5,6,7)+dsm(1,2,3)+Es(1,2,3)+ Ps1(2,3) +Ph(1,2,3,4)+ Pg(3,4) +Pd(3,4,5)+Ps2(1,2,3) +Pf(3,4,5)+Pdr(3,4)+Phg(1,2,3)+Pte(1,2,3,4,5,6,7,8,9,10,11,12) +H(10)+Pr(8,13)+Dg(3)+ Ba(1,2,3,4,5) +Vgo(2,3,4)+Vf(1,2,3,4)+ Si(4,5,7,8)+Cvt(3) +Ha(1,2,3)+Rc(2,3,4)+ Rac(4)
- R7 [Ra]= Cl[abcd(1,2,3,4,5,6,7,8)]+Wc(4)+So(7,8,9,10)+Ct(1,2,3,4,5)+Ch(1,2,3,4)+ Cp(1,2,3,4,5,6,7)+dsm(1,2,3,4,5)+Es(1,2,3,4,5,6,7) + Ps1(3,4) +Ph(1,2,3,4)+ Pg(1,2,3,4) +Pd(5)+Ps2(3,4) +Pf(4,5)+Pdr(4,5)+Phg(1,2,3,4)+Pte(1,2,3,4,5,6,7,8,9,10,11,12) +Pr(8,13) +Dg(4) + Ba(1,2,3,4,5) +Vgo(4,5,6)+ Si(1,3,4,5,6,7,8)+ Rac(4)+Cvt(1,2,3) +Ha(1,2,3,4,5)+Rc(3,4,5) +H(1,2,3,4,5,6,7,8,9,11,12) +Vf(1,2,3,4,5)

3- Ecological preservation:

- Ce= So(9,10) or Es(3,4,5,6,7) or El(4,5) or Phg(4)
- Ce= Ba (1,2) + Bs(1,2)
- Ce= Si (1,2,3,4,5,6,7) or Cvt(1,2) or Ha(1,2,5)
- Ce= H(1,2,3,4,5,6,7,8,9,11,12) + H1(3)
- Ce= Pr(1,2,3,4,5,6,7,8,9,10,11,12)

Definition and classification of ecological data for Modelling (Makhdoum, 2002)

Classes	Elevation (E) m above see level	Slope (So) %	Precipitation (Cp) ml	Temperature (Ct) Centigrade	Humidity (Ch) %	Wind speed (Cw) Km/h	Sunny days per month (Cs)	Climate (de Martin)23 (Cl1)
1	0-100	0-2	-50	?-18	?-40	1-35	0-7	Saharien
2	101-200	2.1-5	51-200	18.1-21	40.1-60	36-60	8-15	Arid
3	201-400	5.1-8	201-500	21.1-24	60.1-80	61-100	15+	Semi-arid
4	401-600	8.1-12	501-800	24.1-30	80.1-100	101+		Mediterainean
5	601-1200	12.1-15	801-1200	30.1 +				Sub-humid
6	1201-1800	15.1-20	1201-2000					Humid
7	1801-2200	20.1-25	2001+					Very Humid (a)
8	2201-2600	25.1-40						Very Humid (b)
9	2601-3000	40.1-65						
10	3001-3400	65.1 +						
11	3401 +							

Definition and classification of ecological data for Modelling (Makhdoum, 2002)

Classes	Soil evolu-tion (Ps1)	Soil Ero-sion (Es) %	Soil Sa-linity (dsm)	Soil's pH	Soil's parti-cles (Pg)	Soil depth (Pd) cm	Soil's gravel (Ps2) %	Soil Fertility (Pf)
1	Well devel-oped	~ 0 (Resis-tent)	0-4	4.2-6	Very small	180+	2-15	Very good
2	Semi-developed	< 25 (small)	4.1-8	6.1-7	Small	121-180	16-50	Good
3	Under de-velopment	25-70 (moderate)	8.1-18	7.1-8.5	Moderate	61-120	51-90	Moderate
4	None-developed	> 70 (high)	18.1-22	8.6-10	Gravel	31-60	90+	Weak
5		Very high (linear Errosion)	+22			-30		Very low
6		Galley						
7		Flood's erosion						

[23] Thare are four different sub-classes for each class, i.e. (a), (b), (c) and (d)

Definition and classification of ecological data for Modelling (Makhdoum, 2002)

Class	Soil's drainage (Pdr)	Soli's hydro-logical groups	Soil Texture	Rock's resis-tance against erosion (El)	Geo-hydrology (H)	Geo-hydrology (under-graound wa-ter) H1	Water dis-charge (Wc) M3/ha	Water tempera-ture (Ctw)	Water pH (Phw)
1	High	A	Sandy	15-17	River bed	Quaterner formations	10000 +	0-15	3.5-5
2	Moderate-good	B	Sandy-loamy	11-13	Flood plain	Before Qu., Cretacea's lime stones and Oligo miocen Lime stones	10000-6000	15-25	5.1-7
3	Moderate-low	C	Loamy-sandy	6-9	Fault	Other lime stones, seam, split & carst	6000-3000	25+	7.1-8.5
4	Low-very low	D	Loamy	2-5	Marn (type I & II)		>3000		8.6-11
5	Very low		Loamy-silty	0.7-2	Riv. Bed & Fault				+ 11
6			Silty		Riv. Bed & Marn				
7			Loamy-clay-sandy		Fl. Plain & fault				
8			Loamy-clay		Fl.plain & Marn				
9			Loamy-clay-silty		Fault & Marn				
10			Clay-sandy		Other forma-tions				
11			Clay-silty		Salty forma-tions				
12			Clay		Sensible fro-mations to erosion				
13			Regosol & lithosol						

Definition and classification of ecological data for Modelling (Makhdoum, 2002)

Classes	Annual Growth of Coni-fers (In1) M3/ha	Annual Growth of deciduous forests (In0) M3/ha	Habitats' situation (Ha)	Intensity of Vegetation cover (Vg0) %	Vegetations'growing forms (Vf)	Range lands' total Fodder production (dreid) Dg - Kg/ha	Range lands' situation (Rc)	Ra.lan.s' car-rying capac-ity (Rac)-stock/ha/100 days
1	-40	+7	Excellent	76-100	Annual grasses & forbs	500	Excellen	2
2	26-40	6.1-7	Normal	51-75	Permannet gr. & fo.	350-499	Good	1
3	13-25	5.1-6	Weak	26-50	Bush	250-349	moderate	0.5
4	7-12	4.1-5	Degraded	6-25	Shrub	-250	Weak	0.25
5		3.1-4	sensitive	1.1-5	tree		Very bad	
6		2.1-3		0-1				
7		1.1-2						
8		-1						

Definition and classification of ecological data for Modelling (Makhdoum, 2002)

Classes	Commercial value of tree species (Bvc)	Conservation value of tree & shrub species (Cvt)	Classes	Protected areas (Pr)	Sensitive habitats (Si)
1	Beech (Fagus orientalis), Oak trees (Quercus sp.), Wych Elm (Ulmus glabra) Mapel (Acer velotinum), Cappadocian maple (A. cappadocicum), Walnut tree (Juglans regia), Lime tree (Tilia begonifolia), Ash tree (Fraxinus excelsior)	Yew (Taxus baccata), Box tree (Boxus hyrcana), Caspian poplar (Populus prsica) Cypress tree (Cupressus semper-virens var. horizontalis), Service tree (Sorbus torminalis)	1	Forest reserve	Mangroves
			2	Forest natural park	Estuaries
			3	Forest park	Wetlands
			4	Natural Park	Savans
			5	National Park	Riversides
			6	Wilde life sanctuary	Coastal hills
2	Black Alder & Alder (Alnus glutinosa & Alnus subcor-data), Hornbeam (Carpinus betulus)	Persian Juniper (Juniperus polycarpus), Junipers (Juniperus sp.), Mangrov tree (Rhizophora macronata), Maple (Acer cinerascens), Wilde cherry (Cerasus avium), Oak tree (Quercus brantii), Pear tree (Pyrus communis)	7	Natural monuments	Forests
			8	Protected area	others
			9	Biosphere Reserve	
			10	World heritage	
			11	Historical Place	
			12	Historical, national, holy place	
3	Other tree species	Other specises	13	other	

Appendix IV

Interview Questionnaire for Villagers, Farmers and Cattlemen

- **Personal information**

1. Age:
2. Sex: Female or Male
3. Number of the family members ……
4. Where do you live? ……
   - Are you a permanent resident? (yes / no)
   - Do you think in the next 10 years, you are going to stay and continue your current living system or you may leave and go somewhere? (yes / no)
   - How about your children? (yes / no / no idea)
5. Education level (Illiterate/ Elementary school/ Middle school, High school diploma, B.Sc/ M.Sc. or over)
6. Livelihood activities:
   - Agriculture (Rain-fed / Irrigated / Garden + … ha + the main agricultural product s ...)
   - Cattle raising / animal husbandry (Number of livestock cow/ sheep/goat + Poultry)
   - Others (Handicrafts / seasonal jobs / permanent job)

Estimation of total incomes (from Agriculture / Animal husbandry / others ... Rials/year)

- **Expectations, basic-needs & conflicts**

7. What are your main expectations from your environment and its natural resources (forests, pastures, rivers, landscapes, etc.): Creating new farmlands / Grazing of the livestock / Collection of firewood and charcoal production / Timber for domestic use / Forests by-products / Hunting / Healthy water (drinking, irrigation) / Amenity values and recreation / settlement /others ……..
8. Could you compare the previous conditions (at least since the last 2 decades)of the natural resources in your area with the current situation?
   - Forests (Total area, qualified tree species and grazing capacity have been decreased / increased / no change)
   - Farmlands (Total area increased but production decreased / both increased / no change)
   - Soil (Soil erosion and landslides have been increased and fertility has been decreased / no change)
   - Climate & annual precipitation (Climate is warmer and dryer and total precipitation has been decreased / no change)
   - Surface and underground water (Quantity and quality have been decreased / no change)
   - Wildlife and game species (Population has been decreased / no change)
   - You see any other important changes (namely …)

9. Could you please, show on this map/ or tell the name of the areas, where you are doing your main livelihood activities? (Your farmlands , Grazing of the livestock, Collection of firewood, Timber for domestic use, Forests by-products, Hunting, Water (drinking, irrigation), Recreation, Settlement, others …)

10. Have you ever had any conflict or problem to use the so-called public resources with your neighbors or other villagers? (Expansion or development of your farmlands / Forests for cattle raising / Forests for collection of fire wood or charcoal / Forests for timber extraction / Forests for hunting and by-products / Rivers or springs for water / others / No problem)
11. Have you ever had any problem to use the so-called public natural resources with Governmental organizations like FRWO, DoE or MAJ departments? ((Expansion or development of your farmlands / Forests for cattle raising / Forests for collection of fire wood or charcoal / Forests for timber extraction / Forests for hunting and by-products / Rivers or springs for water / others / No problem)
12. Regarding your current sources of income, are you satisfied with your economic conditions?
    - Agriculture (Yes / No / not related)
    - Cattle (Yes / No / not related)
    - Forests' by-products / hunting (Yes / No / not related)
    - Other sources (Yes / No / not related)
13. In which section you are satisfied with the services and supports of the Governmental organizations?
    - Rural development and infrastructure (road, electricity, communication, health, education, etc.)
    - Loans and other financial supports for agriculture and animal husbandry
    - Distribution of improved seeds, saplings, fertilizers, pesticides, fodder
    - Training and extensional programs, for agriculture and environmental protection
    - Others?
14. In your opinion, which of the following problems may threaten your current life and livelihood systems? (Forest destruction in your area or adjacent areas / Destruction of the wildlife habitats / Soil erosion, massive movements or land slides / Drought conditions due to climate change / Floods / Water shortage / Air-soil-water pollutions / Destruction of the landscape beauties / None of them / I do not know)

15. If somebody ask you, who is (are) responsible for forest destruction in your area, what may be closer to your answer? (Farmers in my area, because we need to convert forests to create new farmlands / Cattlemen who live in the forests and marginal lands / Villagers who collect fire wood or produce charcoal / Wood smugglers of here and adjacent areas / Private companies, who have the legal permission for timber extraction / FWRO or DoE staffs, due to the lack of proper law enforcement and patrolling / Others … / do not know)

- **Law and enforcement**

16. What is your idea about the environmental protection law and its operational mechanisms, which directly or indirectly affects your life?

- o There is a proper framework but without guarantee for implementation
- o It is not a proper framework, and should be revised based on the social and economic needs of the rural society
- o Law is not important, because everybody can break or interpret it based on his individual/organizational benefits
- o I do not have any idea

Policy & decision making

17. If Government wants to improve your current livelihood system, should it ask your opinion before making any decision?

- o No, because it is responsible/ has knowledge/power to do it not me
- o Yes, because it is my right to be informed before any decision is made for me
- o I do not have any idea

18. In which of the following programs are you eager for active participation in planning and management process? (The current socio-economic and cultural development programs / Land use planning / Rural development / Agricultural development and mechanization / Animal husbandry / Forestry / Range land management /Protected areas' management (national parks, wildlife habitats, wetlands, natural areas, etc.) / Watershed management / Aquaculture / Ecotourism / None of them)

19. Do you think, it is better to affiliate forests to the local communities (based on the historical borders and rights) for protection, management and maintenance? (NO / Yes, why?)

- **Planning & Management**

20. In which section of the planning process do you prefer for any cooperation with Government staffs? (Field studies and inventories / Development of the scenarios and alternatives / Decision making among current and alternative land uses and optimization / Development of the operational programs at local scale / None of them)

- **Implementation, Monitoring & inspection**

21. Based on your idea, what are the main overall weaknesses of the forestry plans in Caspian region, or your area? (conflict with our livelihood system / no attention to use local labor forces / no economic benefits for the local society / Destruction of our environment and forests due to the weak control and inspection / Your idea …)

22. What is your overall idea about the livestock management plan by the FRWO? (It is a good and fair plan for the cattlemen and their families / good plan, but needs further financial and political supports / not a good plan, and brought lot of problems for stakeholders e.g. losing the labor force at rural areas, increase migration rate to the cities, conflicts with other communities, promoting illegal activities, etc. / I think …)

23. What is your overall assessment of Tuba plan by MAJ? (good plan with proper technical and financial supports / not a good plan, due to the weak financial support, training of the farmers and maintenance or low attention to basic needs and priorities of the rural communities / your idea)

- **Public awareness, education and participation**

24. Have you ever participated in any public awareness programs or extensional activities of the Governmental organizations in agriculture or natural resource management?

- o Yes, and they help me to increase my knowledge about my surrounding environment and improve my total production and income
- o Yes, but they were useless for me or never affect my current living system
- o No, I have not (why? …)

25. Have you ever cooperated in any Governmental plan, related to the forests, pasture, or agriculture?

- o Yes, I have participated (which one?: Tuba plan / Pasture rehabilitation / Afforestation / Forest conservation / Timber extraction / FRWO livestock management plan / Construction of check dams, gabions and other mechanical watershed management measures / FAO or GEF or other international/national projects)
- o Are you satisfied with such cooperation (Yes / No)
- o No, I have never participated. What are the main reasons? (Lack of confidence or trust on the suggested activities or the projects' staffs / Lack of time/money or other personal excuses / Challenges with other stakeholders e.g. villagers, neighbors etc. / lack of motivation, financial helps or subsidies from Government / Fear due to the lack of needed knowledge or skills / other ....)

- **Problem analysis & solutions**

26. If you are a farmer; which of the following activities seems more attractive to you. It means you are eager to spend your time, money, farmlands, or labor force to participate in it:

  - o Preservation and control of the forest areas / pastures
  - o Timber extraction and transport
  - o Rehabilitation and afforestation in the degraded forests and pastures
  - o To shift your traditional cultivation system to an environmentally sound and economic system (new cultivation techniques, use of improved races, proper utilization of fertilizers and pesticides)
  - o Horticulture and cultivation of fast-growing trees at sloppy farmlands for wood and fruit production (Agro-forestry)
  - o Cultivation of the alfalfa at sloppy farmlands (agro-forestry)
  - o Cultivation of the pharmaceutical plants (high income)
  - o Community-based activities like, aquaculture, poultry production, apiculture, silkworm, handicraft and dairy product, ecotourism by establishment of the rural cooperatives

27. If you are a cattlemen; which of the following activities seems more attractive to you. It means you are eager to spend your time, money, livestock, or labor force to participate in it:

- o Patrolling and control of the forest areas / pastures
- o Rehabilitation of the degraded forests and pastures
- o Establishment of semi-centralized cattle raising near the villages by technical and financial supports of the Government through:
  - o establishing the community-based cooperatives by stakeholders
  - o exiting the livestock from forests
  - o genetic improvement of the livestock to increase the total product

- cultivation of the fodder crops

28. Are you satisfy with your current energy system based on fire wood?

- Yes, and I do not want to change it in the close future
- No, and I want to improve or change it to another system. If so, what could be closer to your choice?
  - Distribution of cheaper fossil fuel by development of fuel stations at rural areas
  - Increasing the yield of traditional heating system (stoves, heaters, public bathrooms etc.)
  - Trying new energy sources like biogas, wind turbine, solar batteries and small hydro power plants (at rivers) by Government support
  - Firewood cultivation at degraded farmlands (cultivation of mulberry for silkworm culture)

29. What is your best alternative for degraded forest areas, which surrounded by cultivated areas?

- Conservation and promoting natural rehabilitation and regenerations
- Afforestation and conservation
- Converting them to the wood plantations
- Agro-forestry (fodder + garden products)
- Converting to the pastures for cattle raising
- Converting them to the farmlands
- Your idea ……

30. Do you think that the isolated forest patches, which surrounded by your farmlands could be reconnected by development of green spaces?

- No, and I do not like to assign/dedicate or sell a part of my farms for such a purpose
- Yes, but Government should buy my farms for such a purpose
- Yes, and I am ready to participate if an economic activity (wood cultivation) is possible
- Your idea ……...

Appendix V

Interview Questionnaire For Managers & Experts

ATTENTION:

Please, attention that it is not a test, or something to evaluate your level of skills or criticize your current job or organization. We do not need your name or your address. We want to know, whether you are agree with our opinion, regarding your knowledge and experience or have another idea. You are on your own to answer to the questions or not. Some questions have multiple choices, which means you can select one or ,as many as, options which are closer to your mind or seem true to you. In some questions, it is also possible to explain more about your idea, if you think something important missed or should add to the answers.

Thank you in advance for your collaboration!

- **Personal information**

1. Age: (30 or < / 31- 40 / 41-50 / > 50)

2. Sex: (Female / Male)

3. Education level and field of expertise/study (High school diploma / B.Sc / M.Sc /Ph.D)
4. Working background (years): (<5 / 6-10 / 11-20 / 21 or >)
5. Current duty/job: (Education and research / Management / Expert or consultant)
6. Is your current job or responsibility related to your field of study at University?

- If yes, (in your opinion) how does your higher education prepare you for your current tasks/responsibilities? (properly related, satisfied / related but not satisfied)
- If not, which idea shows your opinion/feeling better (my education is not related, but I learned during work and now I am in a good level of skill or experience for this job / the field of study is not important / no idea)

7. Please, explain your levels of agreement/satisfaction with your current job/work by following items:

- Tasks and duties / Collaboration with your manager or directors / Collaboration with your colleagues / Attention to your opinions - skills - experiences in your working environment / Equipments and facilities / People / customers you deal with (satisfied / not satisfied)
- If everything would gone based on your wishes, would you quit your current job and choose your dream/desired job? (Yes / No)

- **Law and enforcement**

8. Which of the followings reflect better your idea about the legal framework for environmental protection and management of the natural resources in Iran? (There is a proper framework but without guarantee for implementation / not a proper framework, should be revised / it is not important / no idea)

9. Do you think that we have proper mechanisms in the law to promote inter collaboration among responsible organizations for protection and management of the natural resources? (Yes / No / no idea)

10. Based on your opinion, what are the most important weaknesses of the Iranian environmental protection act and its subsets? (out of date / puts all of the responsibilities on the Government than society

/ not consider the real social needs or environmental conflicts / Focus more on solving the consequences than finding the root-causes / Your idea …)

- **Policy & decision making**

11. Which one is closer to your idea about policy development and decision making for environmental protection and natural resources management in Iran? (Government should take the task in all levels / made by the Government and society / by the society in a democratic way and implemented by the Government / your idea …)

12. Based on your experience, in which section may the process of decision-making be improved by public participation? (The current socio-economic and cultural development programs / Land use planning / Rural development / Agricultural development and mechanization / Animal husbandry / Forestry / Range land management / Protected areas' management (national parks, wildlife habitats, wetlands, natural areas, etc.) / Watershed management / Aquaculture / Eco-tourism)

13. In your organization, policy and decisions are normally made by the top managers, no revision by lower level / by the special studying groups, revision is possible / you idea …

14. Do you think that the process of policy and decision-making in your organization is: Knowledge-based, with a long term view / Politically-based, with short term priorities and goals / your idea …

15. Do you think it is possible to affiliate forests to the local communities based on the historical borders and rights for management and maintenance? (No / Yes, under supervision of the Government)

- **Organization**

16. Base on your experiences and knowledge, which of the following organizations have overlay on their tasks/duties that may create challenges or problems: (FRWO with DoE / FRWO with DC of MAJ / FRWO with DAH of MAJ / FWRO with DSW of MAJ / FRWO provincial departments with the municipalities / your idea …

17. As you know, FRWO is under supervision of the MAJ, which is mainly responsible for agricultural development and rural construction. Do you think that FWRO should act as an independent organization? (Yes / No)

18. Recently, Department of Watershed management of MAJ has been joined to the former FRO as a new organization; do you think it increases the planning and management abilities of the mentioned organizations? (Yes / No)

19. What is/are the main reason(s) for weak inter-cooperation among MAJ departments, FWRO and DoE?

- Dominance of sector planning and management system of thinking among managers and staffs
- Competition for expansion of the management areas and position among organizations
- Weak capacity building, especially for integrated and holistic planning and management system
- Lack of effective operational mechanism for such cooperation

20. Do you think that all above organizations should come under one organization or Ministry? (No / Yes but it is impossible / Yes and it is possible and necessary / no idea)

- **Planning, Management and Implementation**

21. Based on your experience, do you really believe on planning in different levels (national, regional, provincial and local) in Iran? (No / Yes / your idea)

22. Based on your opinion,

- Planning in all levels should be separately done for each sector (forestry, range land management, agricultural development & animal husbandry, rural development, watershed management and environmental protection) by responsible organizations and also implemented separately by them

- Integrated planning should be done for all levels , in which all sectors/activities are considered in a holistic view, based on the ecological potentials and social needs and then submitted to the responsible organizations for implementation, with close participation of the community in all levels
- I do not have any idea.

**** Are you familiar with the current process of land use planning in Iran? If no, please skip questions 23 to 25 and then continue:**

23. Do you think, there is any difference between Land use planning and other planning methods like landscape planning, forestry, rangelands management, protected areas management, agricultural development? (Yes / no idea)

24. In your opinion, what could be the main weak points of the current methodology for land use planning in Iran? (Data quality and quality assessment of the inputs and outputs / Dimension (scale) / Practicability and reliability of the results / Compatibility with other sector planning procedures and methods / Stakeholders participation / Objectivity against subjectivity (focus on an ideal or a theoretically best plan than finding simple and practicable solutions for the problems) / your idea …)

25. Based on your experience, in which section may the process of land use planning be improved by the public participation? (Data collection, field studies and inventories / Data preparation and analysis / Development of assessment models and (ecological/socio-economic) capability assessment for each kind of land uses / Development of the scenarios and alternatives / Decision making among current and alternative land uses and optimization / Development of the operational programs at local scale / Your idea …)

26. You think, what are the main reasons for improper implementation of the Land use plans in Iran? (Lack of powerful legal mechanism and financial/institutional supports / Dominance of sector planning and management system and lack of inter cooperation among related organizations / Lack of enough knowledge on the integrated planning methodologies among top-managers and experts / Impracticality of the results on the local scale / Top-down nature of the process, as well as, low compatibility to meet the basic needs, cultural and social priorities and real conditions of the rural society / Weak participation of the rural communities due to the low environmental awareness and poverty / Your idea …)

27. Base on your experiences, what are the main overall weaknesses of the forestry plans in Iran? (Dominancy of the sector planning and weak attention to the integrated planning principles and procedures / Top-down nature of the planning, management and implementation and lack or weak public participation / Lack of up-to-date data, weak access to or utilization of the modern technologies (GIS, RS) and environmentally sound silvicultural methods / Focusing more on the economic aspects than ecological functions or conservation values of the forest ecosystems / Weak monitoring, inspection and assessment of the results on both natural and social environments / Your idea …)

28. What is your overall idea about the implementation of livestock management plan (to buy the livestock from cattlemen, who live inside the forests, and then move the people to the down stream by giving farmlands and special areas for settlement) at forest areas of Caspian Region by the FRWO: (successful execution with good results / good plan, but needs further financial and political supports / a short term solution that brought a lot of social and cultural problems / your idea …)

29. What is your overall assessment of Tuba plan by MAJ (distribution of free sapling to the farmers to plant them on the sloppy farmlands to increase the income and to combat soil erosion): (a good plan with good results / not a good plan with weak results due to the weak financial support, training of the farmers and maintenance as well as low attention to the ecological capabilities and basic needs and priorities of the rural communities / your idea …)

- **Public awareness, education and participation**

30. What is your overall assessment on the public awareness programs or extensional activities of the Governmental organizations in agriculture and natural resource management? (good plans with meaningful results / weak plans with weak trust and support of the society / your idea …)

31. You think which social group(s) should be more aimed by the extensional activities of the Government to increase public awareness/participation? (Just stakeholders of the projects / Youth and women / Holy leaders / Local councils / NGOs / Local cooperatives / All of the members' society, as much as, possible / your idea …)

- **Problem analysis & solutions**

In this section, we would like to have your idea about forest destruction and degradation of natural resources in mountainous areas of Caspian region and your possible solutions.

32. In your opinion, what are the main reasons for forest destruction in mountainous areas of Alborz? (Please, give score to the items as 1 for the very important, 2 for semi-important and 3 for the least important reasons)

- o Poverty and lack of environmental awareness among rural communities (score …)
- o High dependency of the rural living system to the forest resources (score …)
- o Traditional cultivation system, esp. dry-farming on steep slopes by conversion of the forest to the farmlands (score …)
- o Livestock grazing in the forests and marginal lands (score …)
- o Collection of fuel wood and charcoal production (score …)
- o Illegal activities and over-extraction by smugglers and private companies (score …)
- o Lack of budget and staff for conservation of the forests, especially in the remote areas (score …)
- o Improper preparation and execution of the forestry plans (score …)
- o Lack of integrated land use plan or environmentally sound alternative livelihoods (score …)
- o your idea … (score …)

33. What is your best alternative(s) to combat forest destruction due to land conversion in northern forests of Iran?

- o Increase the conservation and control measures
- o Severer punishments and fines
- o Increase the total production and income of the villagers/farmers by
    - o promoting cultivation, only on the ecologically capable areas
    - o Introducing environmentally sound cultivation techniques, improved races and methods for proper utilization of fertilizers and pesticides
    - o promoting horticulture and cultivation of fast-growing trees at sloppy farmlands for wood and fruit production (Agro-forestry)
    - o promoting cultivation of the fodder crops at sloppy farmlands (agro-forestry) for semi-centralized cattle raising
    - o promoting cultivation of the pharmaceutical plants (high income)
- o Assignment of green taxes, loans and other financial supports to substitute the low levels of income and decrease the dependency of the villagers to the forests
- o Promoting community-based activities like eco-tourism, aquaculture, poultry production, apiculture, silkworm, handicraft and dairy product by establishment of the rural cooperatives

34. What is your best alternative(s) to combat forest degradation due to livestock grazing in northern forests of Iran?

- o It should be completely quited as soon as possible

- It may be continued on the areas with ecological capability
- It can be substituted by semi-centralized cattle raising near the villages through
    - establishing the community-based cooperatives by stakeholders
    - exiting the livestock from forests to the animal husbandry stations near the villages
    - genetic improvement of the livestock to increase the total product
    - cultivation of the fodder crops as nursery cover/agro-forestry
    - Technical and financial supports from Governmental organizations
- Your idea……

35. What is your best alternative(s) to combat forest degradation due to the firewood collection and charcoal production in mountainous areas of Caspian region?

- Development of the fossil fuel distribution networks at rural areas
- Decrease of the firewood consumption by increasing the yield of traditional heating system (stoves, heaters, public bathrooms etc.)
- Promoting new energy sources like biogas, wind turbine, solar batteries and small hydro power plants (at rivers)
- Firewood cultivation at degraded farmlands (cultivation of mulberry for silkworm culture)

36. What is your best alternative for rehabilitation of the degraded forest areas?

- Afforestation with the commercial fast growing needle leaves species
- Afforestation with the commercial fast growing deciduous species
- Afforestation using endemic species (attention to the characteristics of the plant type/society)

37. What is your best alternative for degraded forest areas, which surrounded by cultivated areas?

- Conservation and promoting natural rehabilitation and regenerations
- Afforestation and conservation
- Converting them to the nurseries or fast-growing plantations
- Agro-forestry (fodder + garden products)
- Converting to the pastures for cattle raising
- Converting them to the farmlands
- Your idea ……

38. What is your best alternative for reestablishment of the ecological corridors among isolated forest patches in agricultural landscapes of the mountainous areas of Alborz?

- Buying the farmlands among isolated patches and afforestaion
- Establishment of buffer zones around isolated patches and development of hedge rows to reconnect them
- Establishment of green corridors among isolated areas by developing fast growing plantations in the cultivated areas
- Your idea ……...

Curriculum Vitae

PERSONAL IDENTITIY

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FILEDS OF INTEREST

- Land use and Landscape planning, Environmental Impact Assessment
- GIS and Remote Sensing Applications in Environmental Protection, Planning and Management
- Participatory Management of the Natural Resources for Sustainable Development

EDUCATION

PhD Apr.2004-March 2008
George-August University of Goettingen, Forest Policy and Nature Conservation Institute; Goettingen, Germany
Major: Landscape Assessment and Planning
Minors: Tropical Forestry and Ecological Pedology

Master of Science Oct.1995–Dec.1997
Tehran University, Natural Resources Faculty, Department of Environmental Sciences; Tehran, Iran (GPA: A)
Major: Environmental Impact Assessment
Minor: Land use Planning, R.S & GIS, Environmental Pollution, Wildlife Management

Bachelor of Science Oct.1991-Oct.1995
Tehran University, Natural Resources Faculty, Department of Environmental Sciences; Tehran, Iran (GPA: A)
Major: National Parks' Planning and Management
Minor: Environmental Pollution, Wildlife Ecology, Wildlife Management

WORKING EXPERIANCE

Research Program, George-August University of Goettingen, Germany

- "GIS-supported environmental assessment for landscape planning – model and requirements on regional and community levels for Iran". In the Forest Policy and Nature Conservation Institute Apr. 2004-April 2008

Senior Expert, Moje-Pooya & Shil-Amayesh Environmental Consultant Engineers Companies, Tehran, Iran Oct. 2001 – 2003

- "Preparation of Tehran Green Belt Integrated Plan" for Tehran Park & Green Space Organization

- "Preparation of an Environmental Impact Statement (EIS) for Sewage Collection System of Kaleibar City in East Azerbaijan Province", a joint project with Omran Mohit-e-Zist Consulting Engineers Co.
- "Preparation of the Environmental Impact Statements (EIS) for Shrimp Culture in Garandhoo and Khalasi Coastal Areas in Hormozgan Province", for the Iranian Fisheries Company

Environmental Expert, International Affairs of the Research and Education Department; Ministry of Agricultural Crusade, Tehran, Iran Dec. 1997-Oct.2001

- UNDP National Consultant in preparation phase of the UNDP-GEF Medium-Sized Project for Yakhkesh Mountains as a community-based model for integrated ecosystem management of the mountain forests in the Caspian Region, Iran
- FAO National Consultant in the Flood Recovery Mission of the United Nations Agencies to the Golestan Province, Iran
- FAO National Consultant in TCP/IRA/0065 (E) – Emergency Assistance to Flood Affected Farmers in Mazandaran Province (Using agro-forestry and biological measures for rehabilitation of the forests and rangelands in order to prevent future floods
- Collaboration in the feasibility studies for watershed management and sustainable use of natural resources in Karoon 2&3 (Khuzestan Province), Lordegan (Charmahal & Bakhtiari Province), Cezar (Charmahal & Bakhtiari Province) and Mardanghomchai (East Azerbaijan) rivers basins, Forests & Range lands Organization – Jame Iran Consulting Engineers Co., Iran
- Preparation of a UNDP-GEF Medium-Sized Project Concept Paper for Dorz & Sayeban area for rehabilitation of the vegetation cover by floodwater spreading method

Research Assistant, Department of the Environmental Sciences, Natural Resources Faculty of Tehran University, Tehran, Iran

- "Preparation of Environmental Impact Statement of Kermanshah Province". University of Tehran – Department of the Environment Oct.1996- Dec. 1998
- "Collaboration in the Socio-economic Assessment of the Community-based Forestry Cooperatives in Mazandaran and Gilan Provinces". University of Tehran - Forests and Range lands Organization April-June 1996
- "Physical Zoning of Kavir National Park". University of Tehran – Department of the Environment March- Oct. 1995

WORKSHOPS

- Introduction to the Environmental Management Systems (EMS) and ISO 14000, Studying Center of the Industrial Development and Reconstruction Organization (SCIDRO), Tehran, Iran Apr.-Jul. 2001
- Introduction to Arcview 3.x, Forest Policy & Nature Conservation Institute of Goettingen University, Goettingen, Germany April 2005
- Introduction to Arc GIS 9.1, Forest Policy & Nature Conservation Institute of Goettingen University, Goettingen, Germany April 2007

TEACHING & TRAININNG ACTIVITIES

- "The First Global Environment Facility (GEF) Training Workshop for the Experts of the Ministry of Agricultural Crusade". Department of Education and Research, Tehran, Iran (1999)
- "Methods for Environmental Impact Assessment (EIA)". Training Workshop for the Experts of Department of the Environment, DOE Training Center, Karaj, Iran (2000)
- "Methods for Environmental Assessment". Environmental College. Department of the Environment, Karaj, Iran (Winter Semester 2001)

PUBLICATIONS & PREPARATIONS

- Nouri, A. 1995."Energy and Tomorrow's World". B.Sc Seminar. Natural Resources Faculty of Tehran University, Karaj, Iran.
- Nouri, A., Farhadi, A., Hosseini, A. 1995. "Physical Zoning of the Kavir National Park". B.Sc thesis. Natural Resources Faculty of Tehran University, Karaj, Iran.
- Nouri, A. 1996. "Remote Sensing Applications for Studying the Marine Environment and Water Pollution". M.Sc Seminar. Natural Resources Faculty of Tehran University, Karaj, Iran.
- Nouri, A. 1998. "Environmental Impact Assessment of Kermanshah Province with the Application of Degradation Model". M.Sc Thesis. Natural Resources Faculty of Tehran University, Karaj, Iran
- Nouri, A., Touraji, M.1999."Guide-Book for the First Global Environment Facility (GEF) Training Workshop in the Ministry of Agricultural Crusade". Department of Education and Research. Ministry of Agricultural Crusade. Tehran, Iran
- Nouri, A., Touraji, M. 2000. "Using GEF Supports for Decreasing National Environmental Problems and Achieving Sustainable Development in Iran". Paper to the first bi-annual congress on the main economic problems of Iran. Research Institute of Economy, Tarbiat Modares University, Tehran, Iran.
- Nouri, A. Touraji, M. 2001. "Using GEF Supports in Sustainable Development and Proper Management of the Marine and Coastal Ecosystems in Iran". Paper to the first congress on sustainable development of marine ecosystems, Ships and Harbor Organization, Tehran. Iran
- Nouri, A.. 2000&2001. "Emergency Assistance to the Flood Affected Farmers in Mazandaran Province. Using Agro-forestry and Rehabilitation Techniques for Protection of Forests and Range Lands and Prevention of Future Floods". Technical reports of TCP/IRA/0065 (E) project to the Food and Agriculture Organizations of the United Nations (FAO). Tehran, Iran
- Nouri, A. 2002. "The Role of Public Participation for Management and Rehabilitation of the Natural Resources and Preventing Future Floods in the Caspian Region". The First International Conference on the Golestan Flood Event (1999). Ministry of Interior, University of Gorgan and UNDP. Gorgan, Iran
- Nouri, A., Buerger-Arndt, R. 2006. "Environment-based Land Use Planning in Iran. An Introduction to the Current Planning Approach, its Capabilities, and Deficiencies Concerning Future Sustainable Development of the Country". The Forest Policy and Nature Conservation Institute of Goettingen University, Goettingen, Germany
- Nouri, A., Buerger-Arndt, R., Yachkeshi, A. 2006. "Environmental Conflicts in the Caspian Mountain forests. An Analysis of the Threats, Consequences and Possible Solutions for Achieving Sustainable Development (Case study: Yakhkesh area)". The

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AWARDS

- "German Academic Exchange Services (DAAD)" scholarship for a PhD Position at George-August University, Goettingen, Germany Oct. 2003- Dec. 2007

SKILLS

Language	Persian, English, German
Computer	Arcview 3.2, ArcGIS 9.x, ERDAS 8.7, ILWIS 3.4, ENVI 4.2
Certification	Test of English by Iranian Ministry of Science & Technology (TOLIMO), 515out of 667 summer 1998
	German Language for Higher Education March.2004