Fachhochschule Köln
Cologne University of Applied Sciences

Institute for Technology and Resources Management
in the Tropics and Subtropics

ITT

Technology, Resource Management and Development

Special Issue
in Honour of Prof. Dr. Hartmut Gaese

Technology and Resources Management
in the Tropics and Subtropics -
State of the Art and Future Prospects

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Contents

Vorwort

Pessimisten unter den Ökologen berufen sich gern auf Garrett Hardins berühmten Essay ‚The Tragedy of the Commons' , auf deutsch etwa ‚Die Tragik der Allmende' (in: *Science* 13.12.1968), in dem er die Bereitschaft der Menschen zur schonenden und nachhaltigen Nutzung gemeinsamer Ressourcen generell sehr skeptisch beurteilte, festgemacht an dem seit der Antike herangezogenen Beispiel der Überweidung einer Gemeindeweide. In der umfangreichen Diskussion dieses Essays wurden jedoch einige wichtige Einschränkungen formuliert:

- Der Nobelpreisträger für Wirtschaft Daniel McFadden hat festgestellt (in: *Forbes* 9.10.2001), „Resource uncertainty contributes to over-harvesting. When there is research based certainty, people estimate the size of the resource and everyone limits how much they can harvest so that there will be enough for next year." Richtig vermittelbare Untersuchungsergebnisse tragen entscheidend zu ressourcengerechtem Verhalten bei.
- Die Politologin Elinor Ostrom verwies darauf (in: *Science* 12.11.1999), dass Entwicklungen eher dann tragisch verlaufen, wenn sie „fundamentally unmanaged" bleiben, wobei Ressourcenmanagement am besten durch „stakeholders on-site" unter Nutzung impliziten Wissens erfolgen sollte.
- Hardin selbst schränkte ein, Pessimismus sei nur dann wirklich berechtigt, wenn „no foreseeable technical solution" existiere. Dabei ging er allerdings davon aus, dass auch technische Lösungen zur Ressourcenschonung oder nachhaltigen Bewirtschaftung in der Regel mit „change in human values or ideas of morality" verbunden sind. Heute ist diese Verbindung allgemein akzeptierte Bedingung für Lösungen zur Vermeidung tragischer Verschwendung (*Athanassios Pitsoulis in: economag 6/2009).*

Betrachtet man die aktuelle Arbeit des ITT vor diesem Hintergrund, dann kann man feststellen, dass genau diese drei den ökologischen Pessimismus verringernden Aspekte eine ganz wichtige Rolle spielen. Zu den strategischen Zielen des Instituts gehört eben die Aufgabe, konkrete Untersuchungsergebnisse nicht nur zu erzeugen, sondern sie auch zur politischen Bewusstseinsbildung zu nutzen. Die Ausbildung von Fachleuten für Ressourcenmanagement, die ihr Wissen vor Ort zur Anwendung bringen und / oder auch ihre persönliche Entwicklung in situ erfahren haben, ist erklärtes Ziel der im ITT angesiedelten Studiengänge. Und die sorgfältige Suche nach technischen Lösungen, die aber immer im Zusammenhang mit Wertewandel und Verhaltensänderung gesehen werden, ist geradezu Markenzeichen des Instituts. Es ist für den Präsidenten der Hochschule, zu deren profilbildenden Instituten das ITT gehört, eine hocherfreuliche Feststellung, dass das ITT den in der wissenschaftlichen Diskussion formulierten Anforderungen an eine sachgerechte, lösungsorientierte, zu Optimismus berechtigenden Arbeit im Bereich ‚Technology, Resource Management & Development' voll entspricht.

Die Beiträge der vorliegenden Sonderveröffentlichung der ITT-Schriftenreihe bestätigen diesen Anspruch und spiegeln das Selbstverständnis des Instituts wieder. Ja mehr noch – sie werfen auch ein bezeichnendes Licht auf den Forscher und Lehrer, der als langjähriger Direktor des ITT diesen strategischen Ansatz entwickelt und im Selbstverständnis des Instituts verankert hat. Dass die Autoren nicht nur ausgewiesene, in Forschung und Lehre und in der Anwendungspraxis tätige Wissenschaftler, sondern zugleich Kollegen oder Weggefährten von Hartmut Gaese sind, macht deutlich, dass sein und des Instituts Bemühen um den Aufbau und die Vermittlung von Kompetenz für Technologie- und Ressourcenmanagement in den Tropen und Subtropen den Interessen der einschlägigen Scientific Community entspricht.

Mein Bezug auf die berühmte ‚Tragik der Allmende' kommt nicht von ungefähr. Auch Hartmut Gaese liebt es ja, die globalen Fragen, mit denen sich das ITT zu befassen hat, immer wieder auf die einfachen Grundfragen zurückzuführen, die sich dem Landwirt stellen. Die Erde, deren Zukunft wir bewahrend zu gestalten haben, ist die Allmende. Und Hartmut Gaese hat sein Berufsleben erfolgreich der Aufgabe gewidmet, zu ihrer nachhaltigen Bestellung und Nutzung beizutragen. Diese Veröffentlichung ist ein kleiner Dank hierfür.

Prof. Dr. Joachim Metzner

Die ökologische Lücke in den Millennium - Entwicklungszielen

Prof. Dr. em. Franz Nuscheler

Es war für den Autor dieses Beitrags immer eine Ehre, von dem mit dieser Festschrift geehrten Hartmut Gaese an das in der entwicklungswissenschaftlichen Community hoch angesehene ITT der FH Köln zu einem Vortrag eingeladen zu werden. Er hat deshalb keine dieser jedes Jahr ergangenen Einladungen verpasst. Die Themen der Vorträge kreisten immer um das entwicklungspolitische Schlüsselproblem der globalen nachhaltigen Entwicklung und der Verkoppelung von Umwelt- und Entwicklungspolitik.

Dieser Beitrag stellt die Frage, ob das zur Jahrtausendwende von der Staatengemeinschaft beschlossene Großprojekt der Millennium Development Goals (MDGs) dem Prinzip Nachhaltigkeit den ihm gebührenden Stellenwert eingeräumt hat. Die zu begründende Hypothese lautet, dass die MDGs eine ökologische Lücke haben und den unauflösbaren Zusammenhang von Umwelt- und Entwicklungspolitik doch aufgelöst haben.

Das Umweltproblem ist ein Kernproblem internationaler Entwicklung

Die entwicklungspolitische Diskussion über die MDGs übersieht häufig einen elementaren Zusammenhang: Die MDGs 1-6 können nicht erreicht werden, wenn das siebente MDG, nämlich der Schutz der Umwelt und die nachhaltige Nutzung der verknappenden natürlichen Ressourcen, vernachlässigt werden. Inzwischen wurde auch eine sicherheitspolitische Dimension des globalen Klimawandels erkannt. In einem öffentlich gewordenen Bericht des Pentagon wurden seine Auswirkungen auf die westliche Sicherheit zum Missfallen der Pentagon-Führung sogar als bedrohlicher eingeschätzt als der internationale Terrorismus. Der Bestseller-Autor Jared Diamond (2005) machte in einem voluminösen Buch über den „*Kollaps*“ nicht Kriege, sondern den Klimawandel, Umweltschäden und die Zerstörung der natürlichen Ressourcen für den Untergang ganzer Völker verantwortlich. Dieser Prophet der Umwelt-Apokalypse mag biblische Horrorszenarien ausmalen, kann sich aber dabei auf wissenschaftlich fundierte Zukunftsszenarien stützen.

Umwelt- und Entwicklungsforscher haben die Gefährdung der menschlichen Sicherheit (*human security*) durch Umweltkrisen erkannt. Viele Menschen und besonders Frauen und Kinder sind inzwischen existentiell durch Umweltkrisen mehr betroffen als durch Kriege. Die „Feminisierung der Armut“ hat neben Strukturen der Geschlechterungleichheit auch ökologische Ursachen. Die Zahl der Umweltflüchtlinge, die der Zerstörung ihrer Lebensgrundlagen zu entfliehen versuchen, übersteigt inzwischen die Zahl der Kriegsflüchtlinge. Prognosen des IKRK (Internationalen Komitees des Roten Kreuzes) sehen in der Umweltflucht den künftig stärks-

ten push-Faktor von internationalen Migrationsströmen. Auch sie werden in den potenziellen Zielländern zunehmend als Sicherheitsproblem perzipiert. Das Umweltproblem ist also kein Randproblem, sondern ein Kernproblem internationaler Entwicklung und der internationalen Politik.

Analyse der Problemlage, die dem MDG 7 zugrunde liegt

Die Rio-Konferenz von 1992, die als UNCED (*UN Conference for Environment and Development*) bereits Entwicklung mit dem Schutz der Umwelt in einen unauflösbaren Zusammenhang gebracht hatte, rückte den Tatbestand der ökologischen Gefährdung des Planeten und der Zerstörung von natürlichen Lebensgrundlagen im Bewusstsein einer breiteren Öffentlichkeit. Die wissenschaftlichen Erkenntnisse von internationalen Expertengruppen, die in die von UNCED verabschiedete *Agenda 21* eingeflossen waren, wurden durch die Berichte des IPCC (*International Panel on Climate Change*), die GEO-Berichte von UNEP (UN-Umweltprogramm) und durch das *Millennium Ecosystem Assessment* aktualisiert und dramatisiert.

Diese Erkenntnisse lagen auch dem Jahresgutachten 2004 des WBGU (*Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen*) mit dem richtungsweisenden Titel „Armutsbekämpfung durch Umweltpolitik“ zugrunde (WBGU 2005). Im Hinblick auf die Untergewichtung der Umweltpolitik im MDG-Zielkatalog ist der Hinweis wichtig, dass dieses Gutachten der Umweltpolitik eine strategische Schlüsselrolle bei der Armutsbekämpfung zuwies. Seine Handlungsempfehlungen, die wesentlich konkreter als die Unterziele und Indikatoren des MDG 7 sind, beruhten auf einer Analyse des systemischen Zusammenhangs von Armutsdimensionen und Umweltveränderungen, den die MDGs ebenfalls nicht erkennen lassen.

Die wissenschaftlichen Erkenntnisse sind eindeutig und können selbst von ökologischen Dinosauriern kaum noch bestritten werden: Die Eingriffe des Menschen in das Ökosystem gefährden bereits heute in vielen Teilen der Erde die natürlichen Lebensgrundlagen, vor allem der Armutsgruppen und hier wiederum der Frauen. Sie sind gegenüber Umweltkrisen (Wassermangel, Bodendegradation) besonders verwundbar und existentiellen Risiken (Ernteverlusten, Hunger, Krankheiten) besonders ausgesetzt; sie leiden besonders unter Naturkatastrophen, deren Häufigkeit und Intensität nach Berichten von internationalen Organisationen und Versicherungsunternehmen zunimmt (vgl. Scholz 2007); sie verfügen auch über geringe Bewältigungs- und Anpassungsfähigkeiten (*coping capacities*). Deshalb unterschied die natur- und sozialwissenschaftliche Vulnerabilitätsforschung eine soziale Vulnerabilität von der geophysikalischen Vulnerabilität, die auf die Exposition einer Region oder Bevölkerungsgruppe gegenüber Naturkatastrophen abhebt. Allerdings wurde auch bei solchen Naturkatastrophen deutlich, wie aus ihnen – etwa bei Erdbeben oder bei der Tsunami-Katastrophe – soziale Katastrophen oder sogenannte *class-quakes* entstehen können.

Für die geo- oder biophysikalische Vulnerabilität legte der *International Panel on Climate Change* (IPCC) umfassende Analysen und Prognosen vor. Er untersuchte vor allem Folgen des

globalen Klimawandels, die in der Zunahme von Wetterextremen, Veränderungen der Wasserkreisläufe und im Ansteigen des Meeresspiegels liegen und unterschiedliche Auswirkungen auf einzelne Regionen und Länder haben (vgl. Dietz 2006). UNDP (2004) veröffentlichte unter dem Titel „*Disaster Risk*" einen umfassenden Vulnerabilitätsbericht, der die besondere Verwundbarkeit von Armutsgruppen und indigenen Volksgruppen, zu denen immerhin 350 Millionen gezählt werden, durch Umweltkrisen belegte.

Allerdings hatten weder die internationale Entwicklungspolitik noch die internationale Umweltpolitik die Integration und Kohärene der beiden Politikbereiche, wie sie die Rio-Konferenz gefordert und in ihrer *Agenda 21* ausgearbeitet hatte, hinreichend in Strategien und Programme umgesetzt. Die Weltbank lieferte in ihrem Weltentwicklungsbericht 2003 zwar eine überzeugende Vision von nachhaltiger Entwicklung, konnte aber selbst nicht verschweigen, dass diese medienwirksame Rhetorik wenig Einfluss auf ihre operativen Abteilungen hat, die über Programme und Projekte entscheiden.

Statt gemeinsamer „globaler Verantwortung" ein Feilschen um Positionsvorteile

Die Millennium-Erklärung von 2000 betonte geradezu emphatisch die „globale Verantwortung" staatlicher und privater Akteure für das Überleben der Menschheit in einer gesunden Umwelt. Philosophen und Ethiker beschwören eine planetarische Verantwortungsethik, aber die internationale Politik, auch die internationale Umwelt- und Entwicklungspolitik, orientieren sich nicht an einem wie auch immer definierbaren Weltgemeinwohl, sondern an je eigenen Interessen der Akteure und Akteursgruppen. Auch das aufgeklärte Eigeninteresse tut sich schwer, dem in vielen UN-Dokumenten angemahnten Imperativ kollektiven Handelns Folge zu leisten.

Warum die Imperative der Nachhaltigkeit im Ranking der MDGs eher den Stellenwert einer pflichtschuldigen Marginalie denn eines dem Problem angemessenen Stellenwert erhielten, liegt auch an der unterschiedlichen Interessenlage von Industrie- und Entwicklungsländern. Letztere halten den Umweltschutz noch immer für einen postmaterialistischen Luxus der reichen Länder und können mit guten Gründen darauf verweisen, dass die OECD-Länder für den Klimawandel und für die Verschwendung knapper Ressourcen hauptverantwortlich sind; dass sie deshalb nach dem in der Rio-Erklärung bekräftigten Prinzip der Verantwortung mehr für die Abmilderung der negativen Auswirkungen des Klimawandels auf andere Weltregionen und künftige Generationen tun müssten.

Während in Rio, damals unter dem Druck der OECD-Länder, der Umweltschutz im Vordergrund stand, gaben die Entwicklungsländer auf dem Johannesburger *World Summit for Sustainable Development* (WSSD) den sozialpolitischen Zielen und Forderungen der ersten sechs MDGs Priorität. Damit konnten sich auch die Schwellenländer arrangieren, die zwar nicht zur Zielgruppe der MDGs gehören, aber ihren stark wachsenden Energie- und Ressourcenver-

brauch hinter sozialpolitischen Forderungen verstecken konnten. Den vielen anderen Entwicklungsländern gelang es mit ihrem numerischen Stimmenübergewicht bei UN-Konferenzen, das im MDG 7 postulierte Prinzip der Nachhaltigkeit durch Forderungen nach einer besseren Wasserversorgung und Abwasserentsorgung aufzuweichen. Sie gewannen auf internationalen Umwelt- und Entwicklungskonferenzen mehr Einfluss als auf Handelskonferenzen, weil die OECD-Länder beim Versuch, internationale Regelwerke zu schaffen, auf ihre Kooperation angewiesen sind (vgl. Biermann 1998). Bei der Bewertung des MDG-Zielkatalos müssen also diese unterschiedlichen Interessenlagen und Verhandlungspositionen im diplomatischen Poker um Problemlösungen berücksichtigt werden.

Die Millennium-Erklärung als Referenzdokument

Die Millennium-Erklärung zählt den „Schutz der gemeinsamen Umwelt" zu den vier prioritären Handlungsfeldern der internationalen Entwicklungspolitik und bekennt sich ausdrücklich zu den von der Rio-Konferenz über „*Umwelt und Entwicklung*" (UNCED) formulierten Prinzipien einer nachhaltigen Entwicklung (*sustainable development*). Sie verengt aber in den nachfolgenden Absichtserklärungen und Handlungsempfehlungen den diffusen Begriff der Nachhaltigkeit auf den Umweltschutz, der in der Rio-Agenda 21 nur einen, obgleich prioritären Eckpunkt in der Dreifaltigkeit von wirtschaftlicher Dynamik, sozialer Gerechtigkeit sowie dem Schutz der Umwelt und schonender Ressourcennutzung bildet. Unzählige Publikationen, Konferenzberichte, Erklärungen von Regierungen und nationalen Nachhaltigkeitsräten und zuletzt die Abschlussdokumente des Johannesburger *Weltgipfels über nachhaltige Entwicklung* (WSSD) von 2002 haben diese Mehrdimensionalität von *sustainable development* hervorgehoben. Dagegen beschränkte die Millennium-Erklärung die „ersten Schritte" einer „neuen Ethik" des Naturschutzes (*conservation*) und der Fürsorge (*stewardship*) auf die folgenden umweltpolitischen Schwerpunkte:

- die Inkraftsetzung des Kyoto-Protokolls zur Reduzierung der für den globalen Klimawandel hauptverantwortlichen CO_2-Emissionen – eine Forderung, die sich allerdings die USA als größter CO_2-Emittend nicht zueigen machte und die bei Emissionen von klimaschädigenden Gasen aufholenden „asiatischen Elefanten" China und Indien noch nicht verpflichtete;
- die nachhaltige Nutzung von Wäldern;
- die Umsetzung der Konventionen über die Biodiversität und Bekämpfung der Desertifikation (der sog. „*Wüstenkonvention*") in Ländern, die besonders unter Trockenheiten und der Degradation von agrikulturell nutzbaren Böden leiden;
- die Beendigung der Wasserverschwendung durch ein besseres Wassermanagement auf regionaler, nationaler und lokaler Ebene sowie die Förderung eines für alle erschwinglichen und gerecht verteilten Wasserangebots;

- die Verstärkung der internationalen Kooperation zur Verringerung natürlicher und vom Menschen gemachten Katastrophen und zur Abmilderung ihrer Auswirkungen auf die Menschen;
- Sicherung des freien Zugangs zu Informationen über die menschliche Genome-Sequenz.

Wichtiger als diese Einzelforderungen war die hohe Gewichtung des „Schutzes der gemeinsamen Umwelt" im Quartett der vier prioritären entwicklungspolitischen Handlungsfelder. Deshalb ist es wichtig, den MDG-Zielkatalog im Kontext der Erklärung zu interpretieren, die mehr Substanz als das quantifizierte MDG 7 enthält. Sie lässt auch erahnen, warum im Jahr 2004 der Friedensnobelpreis an die kenianische Menschenrechts- und Umweltaktivistin Wangari Maathai vergeben wurde: Weil Frauen bei der Ernährungssicherung, bei der Versorgung mit Trinkwasser und Brennholz im besonderen von lokalen Umweltkrisen betroffen sind und sich deshalb besonders für den Naturschutz engagieren.

Der diffuse Inhalt des MDG 7:
Verflüchtigung des Leitbildes der globalen nachhaltigen Entwicklung

Die in der Erklärung erhobenen Forderungen tauchen nur teilweise im MDG 7 wieder auf und werden durch einige Unterziele ergänzt, die nicht gerade zur Präzisierung des Kernziels beitragen, das lautet: Sicherung der ökologischen Nachhaltigkeit (*environmental sustainablility*). Das Unterziel 9 fordert ganz allgemein die Integration von Prinzipien der nachhaltigen Entwicklung in Länderprogramme, ohne diese Prinzipien zu präzisieren, sowie ein Zurückdrehen des Verlusts von natürlichen Ressourcen. Als das eigentlich Neue der MDGs in der Geschichte der internationalen Umwelt- und Entwicklungspolitik wurde häufig hervorgehoben, dass die Verwirklichung der Ziele an konkreten Ziel- und Zeitvorgaben orientiert und mit Hilfe von Indikatoren überprüfbar gemacht wurde. Deshalb ist es aufschlussreich, welche Unterziele und Indikatoren zur Operationalisierung und Konkretisierung des Oberziels ausgewählt wurden. Bei der Auswahl von Indikatoren geht es auch darum, für welche Messversuche einigermaßen zuverlässige Daten vorliegen. Für das MDG 7 sammelte das *UN-Department of Economic and Social Affairs* alle verfügbaren Daten. Die *UN Statistics Division* baute eine umfassende *Millennium Indicators Database* auf.

Als messbare Indikatoren für den "Schutz der gemeinsamen Umwelt" dienen der Anteil von Waldflächen und von Schutzflächen zur Bewahrung der Biodiversität und genetischen Ressourcen an der Gesamtfläche eines Landes sowie die Pro-Kopf-Emissionen von Kohlendioxid. Dies sind aussagefähige Indikatoren, obgleich das Messbare nicht immer das Wichtigste erfasst. Weil die Produktion und der Verbrauch von Energie die Hauptquelle von Treibhausgasen und damit die Hauptursache der Erderwärmung mit ihren multiplen Auswirkungen (Häufung von Wetterextremen, Ansteigen des Meeresspiegels, Überflutung von tief liegenden Inseln und

Siedlungsgebieten) bildet, wurde das Bruttoinlandsprodukt pro Einheit des Energieverbrauchs als Maßstab für die Energieeffizienz hinzugefügt. Hinter solchen statistischen Operationen steht der Sachverstand von Statistikabteilungen der internationalen Organisationen, hier des oben erwähnten *UN-Department of Economic and Social Affairs*.

Diese UN-Behörde fügte einen wichtigen Indikator hinzu, der unter den MDG-Indikatoren nicht auftaucht: nämlich die Belastungen durch die häusliche Luftverschmutzung, die durch das Verbrennen von Biomasse (Holz, Dung etc.) zum Kochen und Heizen entstehen. Nach Schätzungen der WHO fallen dieser Vergiftung von Innenräumen jährlich 900.000 Kinder und 700.000 Erwachsene, darunter vor allem Frauen, zum Opfer. Eigentlich hätte dieser Tatbestand von den MDGs 3+4 erfasst werden müssen, wird aber dort nicht aufgegriffen. Es gibt also nicht nur eine Energieverschwendung, die für eine nicht-nachhaltige Produktions- und Lebensweise steht, sondern auch eine Energiearmut bzw. einen Mangel an sauberer Energie, der die Entwicklung behindert, das tägliche Leben erschwert und die Gesundheit gefährden kann.

Es kommt nicht zusammen, was zusammen gehört

Man kann darüber streiten, ob die Indikatoren zum MDG 7 hinreichend Fort- oder Rückschritte beim Umweltschutz messen können. Eine Vermehrung und Verfeinerung von Indikatoren hätte kaum einen größeren Erkenntnisgewinn gebracht. Unverständlich ist dagegen, warum das 10. Teilziel, nämlich die Halbierung des Anteils von Menschen ohne Zugang zu sauberem Trinkwasser, unter dem MDG 7 und nicht unter dem zentralen MDG 1 auftaucht, das den Dreh- und Angelpunkt des MDG-Zielkatalogs bildet. Hier fordert das 2. Teilziel die Halbierung des Anteils von Menschen, die unter Hunger leiden.

Hunger und der mangelnde Zugang zu Trinkwasser, der eine Vielzahl von Syndromen verursacht, welche die MDGs 4 bis 6 aufzählen, sind elementare und zusammenhängende Manifestationen von Armut. Der Zugang zu Trinkwasser und zu elementaren sanitären Anlagen ist eine unverzichtbare Komponente der Gesundheitsfürsorge und des Kampfes gegen Armut. Wasser ist die Grundlage allen Lebens und deshalb gilt der Zugang zu ihm als Menschenrecht. Das nachhaltige Wassermanagement kann zwar dem im MDG 7 geforderten Ressourcenschutz zugeordnet werden, aber in dessen Systematik, die den Umweltschutz im MDG-Zielkatalog verankern soll, ist das 10. Teilziel ein Fremdkörper.

Es kommt zusammen, was nicht zusammen gehört

Noch kritikwürdiger ist das 11. Teilziel, das – wohlgemerkt unter dem Oberziel der „*environmental sustainability* – die Verbesserung der Lebensbedingungen von 100 Millionen Slumbewohnern bis zum Jahr 2020 fordert. Schon jetzt hausen nach Schätzungen von *UN-Habitat* über 900 Millionen in Slums und bis zum Stichjahr 2020 wird diese Zahl im Gefolge der rasanten Urbanisierung in vielen Entwicklungsländern auf 1,4 Milliarden anwachsen. Die Indikatoren 30+31 weisen darauf hin, dass die SlumbewohnerInnen unter völlig unzureichenden sanitären Anlagen, deren Fehlen Slums in stinkende Kloaken verwandeln, und unter ungesicherten Besitz- und Nutzungsrechten leiden. Aber dies gilt nicht nur für die Minderheit von 100 Millionen. Es ist nicht zu erkennen, warum dieses sozialpolitische Ziel im Kontext des MDG 7 auftaucht, obwohl die häufig im Dreck und Gestank versinkenden Slums auch ein gravierendes Umweltproblem darstellen, vor allem dann, wenn die Umwelt im umfassenden Sinne als *livehihood* verstanden wird.

Das MDG 7 verengt einerseits den Begriff der Nachhaltigkeit auf den Umweltschutz und überfrachtet es andererseits mit sozialpolitischen Forderungen, die nicht zu seinen konstitutiven Begriffsinhalten zählen. Die Teilziele 10+11 sowie die dazu gehörenden Indikatoren vermitteln den Eindruck, dass Nachhaltigkeit für die Konstrukteure des MDG-Zielkatalogs als eine Allerweltsformel ohne spezifische Konturen herhalten musste. Eine Nachhaltigkeitspolitik ist auch im engeren Sinne der Umweltpolitik für die nachhaltige Bekämpfung der Armut so wichtig, dass sie nicht zum konturlosen Konglomerat von sozialpolitischen Forderungen für die andere Ober- und Teilziele zur Verfügung standen, hätte abgewertet werden dürfen. Auf diese Weise verflüchtigte sich im MDG-Zielkatalog das Leitbild der globalen nachhaltigen Entwicklung.

Vorschläge zur Verkoppelung von Umwelt- und Entwicklungspolitik

Es war eine Kernthese des WBGU-Gutachtens „*Armutsbekämpfung durch Umweltpolitik*“, dass die MDGs 1-6 nicht erreicht werden können, wenn der Schutz der Umwelt und der natürlichen Lebensgrundlagen vernachlässigt wird. Deshalb gehören Umwelt- und Entwicklungspolitik untrennbar zusammen, müssen zusammen gedacht und in kohärente Strategien umgesetzt werden. Nur eine integrative und kohärente Verknüpfung der beiden institutionell noch immer getrennten Politikbereiche kann dem in Rio entworfenen Leitbild einer nachhaltigen, d. h. wirtschaftlich zukunftsfähigen, aber zugleich umwelt- und sozialverträglichen Entwicklung gerecht werden. Das vom WBGU konstruierte „*Rio-Rad*“ verdeutlicht die teilweise schon funktionierenden, aber der Verstärkung bedürftigen Kopplungen zwischen globaler Umwelt- und Entwicklungspolitik und die Wechselwirkungen zwischen den beiden Politikbereichen.

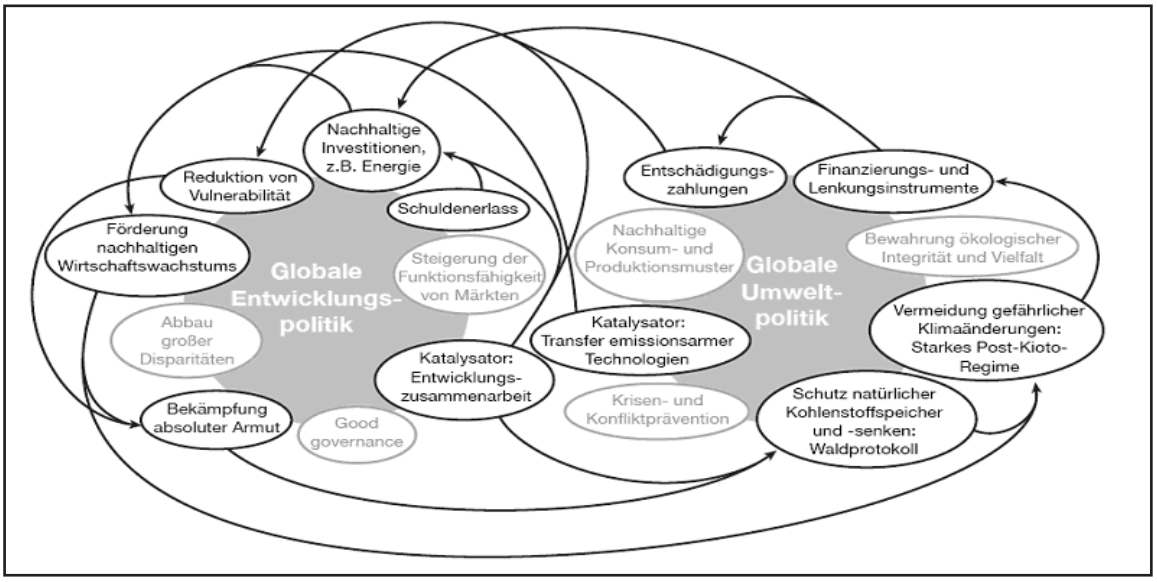

Abb. 1: Rio-Rad des WGBU, Quelle WGBU 2005

Weil der MDG-Zielkatalog das Resultat diplomatischer Verhandlungen war, die auf einen größtmöglichen Konsens abzielten und deshalb strittige Punkte ausklammerten, drückten sie sich auch darum, institutionelle Konsequenzen aus dem Imperativ der Nachhaltigkeit zu ziehen. Dazu gehört die von vielen europäischen Regierungen geforderte Aufwertung des personell unterbesetzten und mit einem schwachen Handlungsmandat ausgestatteten UNEP zu einer dem Problemdruck eher angemessen UN-Sonderorganisation.

Weil die Umwelt- und Entwicklungspolitik auf allen Politikebenen noch von verschiedenen Organisationen und nicht nur in Deutschland auch von verschiedenen und häufig miteinander konkurrierenden Ressorts behandelt werden, muss über ihre institutionelle Verzahnung nachgedacht werden, die über eine statuarische Aufwertung des UNEP hinausgeht. Umwelt- und Entwicklungsfragen sind Zukunftsfragen der Menschheit, deren Bewältigung für die Bewahrung der *global common goods* oder für die Vermeidung von *global common bads* unverzichtbar ist. Sie sollten deshalb im UN-System ebenso hoch verankert werden wie Sicherheitsfragen. Der UN-Sicherheitsrat kümmert sich jedoch nicht um Probleme, die für die Mehrheit der Menschheit von existentieller Bedeutung sind, und der eigentlich zuständige UN-Wirtschafts- und Sozialrat (ECOSOC) ist ein handlungsunfähiges Diskussionsforum, das viele Resolutionen produziert, aber keine relevanten Entscheidungen treffen kann. Für die Bearbeitung von Entwicklungsfragen wurde ein Wildwuchs von UN-Organisationen geschaffen, die mit mehr oder weniger Effizienz spezielle Problemfelder bearbeiten, dabei aber schwerwiegende Koordinations- und Kohärenzprobleme schaffen.

Der WBGU (2005) entwarf deshalb die Vision eines *Global Council for Development und Environment*, der den moribunden ECOSOC ablösen und im UN-System institutionell zusammenführen sollte, was die Rio-Konferenz von 1992 unter dem Konferenztitel „*Environment*

and Development“ bereits programmatisch angedacht hatte. Diese Vision stößt zwar bei Industrie- und Entwicklungsländern noch auf viele Widerstände, zumal es im UN-System noch viele andere Baustellen gibt. Visionen können jedoch langfristigen Überlegungen zu Problemlösungen eine Orientierung geben. Und die ökologische Gefährdung des Planeten ist ebenso ein Menschheitsproblem ersten Ranges wie das Armuts- und Sicherheitsproblem. Sie bilden zusammen die eingangs erwähnte Triade der Megaprojekte.

Wir nähern uns dem ökologischen point of no return

Das MDG 7 trug nicht dazu bei, der Umweltpolitik einen höheren Stellenwert in der internationalen Entwicklungspolitik zu verschaffen und ihren unverzichtbaren Beitrag zur Armutsbekämpfung zu verdeutlichen. Weil eine zielgerichtete Politik der Nachhaltigkeit auf allen politischen Handlungsebenen die Voraussetzung für eine nachhaltige Bekämpfung der Armut ist, ist die Untergewichtung der ökologischen Nachhaltigkeit im Prioritätenkatalog der MDGs inkonsequent und fällt hinter den Erkenntnisstand der Rio-Konferenz zurück, die vor nun 17 Jahren stattfand.

Es ist deshalb dringend geboten, den von den MDGs verdrängten „*Geist von Rio*“ zu reanimieren, um dem Ungeist der ökologischen Bedenkenlosigkeit, wie ihn China in seiner Wachstumsmanie pflegt, zu begegnen. China erzielte zwar große Erfolge bei der Armutsbekämpfung, die die weltweite Armutsquote deutlich senkte, ist aber dabei, durch die selbstzerstörerische ökologische Rücksichtslosigkeit die eigene Zukunftsfähigkeit zu verspielen. Ihre Kosten verzehren bereits ein rundes Zehntel des Bruttosozialprodukts (vgl. Scholz 2007). Weil die Schwellenländer bzw. Ankerländer nach der Sprachregelung des *Deutschen Instituts für Entwicklungspolitik* (DIE), allen voran China und Indien, beim Ressourcenverbrauch und bei CO_2-Emissionen zu den OECD-Ländern aufschließen und die meisten von ihnen bald überholen werden, müssen sie stärker als bisher in die globale Umweltpolitik einbezogen werden. Der Beitrag der beiden Länder zu den weltweiten CO_2-Emissionen könnte im Jahr 2030 schon bei etwa 50 % liegen, wenn nicht die Abkoppelung des Wirtschaftswachstums von CO_2-Emissionen gelingen sollte.

Die ökologische Wende, die eine Energiewende voraussetzt (vgl. WBGU 2003), erfordert allerdings nicht nur viel politische Weitsicht und Energie, sondern wird auch viel Geld kosten. Nach Schätzungen des WBGU müssten allein die OECD-Länder jährlich rund 1 % ihres Bruttosozialprodukts investieren, um die voranschreitende Zerstörung des globalen Ökosystems durch eine globale Umwelt- und Entwicklungspolitik aufzuhalten. Der ehemalige Chefökonom der Weltbank Nicolas Stern (2007) prognostizierte bei Nichthandeln massive weltwirtschaftliche Einbrüche. Weil auch auf die Entwicklungs- und Schwellenländer große umweltpolitische Herausforderungen zukommen, ist es offensichtlich, dass neue Finanzierungsinstrumente – wie die Tobin-Steuer oder eine globale CO_2-Steuer – geschaffen werden müssen. Ein weiteres Abwarten und Hinauszögern würde den ökologischen *point of no return* vorziehen, der auch die Armutsbekämpfung in die Sackgasse führen würde.

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Afrika - ein verlorener Kontinent?

Eine kritisch-analytische Betrachtung und der Versuch eines Ausblicks

Prof. Dr. Ulrich Daldrup

Europa als unmittelbarer Nachbar Afrikas hat ein ganz spezifisches Interesse an der Entwicklung dieses Kontinents, einer stabilen Staatlichkeit und Afrika als potentiellem Wirtschaftspartner. Unser Institut, das ITT – Institut für Technologie in den Tropen – hat eine besondere Aufgabe: Junge Akademiker für die komplexen Aufgaben internationaler Zusammenarbeit, Ressourcenmanagement und die Entwicklung der tropischen und sub-tropischen Gebiete zu qualifizieren. Der Anteil von Studenten aus dem Teil südlich der Sahara ist dabei eher gering. Ein Grund mehr, einen Blick auf eben dieses Afrika südlich der Sahara zu werfen.

Afrika ist unstrittig einer der landschaftlich reichsten Kontinente mit unermesslichem Potential: Bodenschätze, Landwirtschaft, Arbeitskräfte, Natur, Tourismus u.v.m. . Dennoch: Afrika gilt als das Armenhaus unserer Welt. Afrika, eben reich an Rohstoffen, Energiereserven und Arbeitskräften, bleibt in Armut gefangen. Ökonomisch spielen die Länder südlich der Sahara so gut wie keine Rolle mehr, ihr Anteil am Welthandel liegt unter zwei Prozent. Afrika stellt 13,2 Prozent der Menschheit - erwirtschaftet aber nur 1,2 Prozent des Weltsozialprodukts. Einen Wirtschaftsstandort Afrika gibt es eigentlich gar nicht. Der Kontinent, der vor 1960 Nahrungsmittel exportierte, ist heute ein Nahrungsmittel-Großimporteur, in vielen Fällen sogar abhängig von wohltätiger Nahrungshilfe. Die Weltbank hat ermittelt, dass allein der Sudan das landwirtschaftliche Potential hätte, den gesamten afrikanischen Kontinent mit Nahrungsmittel zu versorgen - die Betonung liegt auf „hätte“.

Afrika ist der Kontinent mit dem höchsten Bevölkerungswachstum. Während die Wachstumsrate der Weltbevölkerung auf unter 1,4 Prozent gesunken ist, liegt sie in Afrika trotz aller Heimsuchungen durch Kriege, Hunger und AIDS bei 2,4 Prozent, in West- und im mittleren Afrika zwischen 2,5 und 2,7 Prozent. Seinen gegenwärtigen Anteil von 13 Prozent der Weltbevölkerung wird Afrika auf voraussichtlich 20 Prozent (2025) steigern und es wird von heute 800 Millionen auf 1,3 Milliarden Menschen anwachsen, bis 2050 auf 1,8 Milliarden. Das subsaharische Afrika hat hier den größten Anteil. Ist es heute Heimstatt für 525 Millionen, wird es dies 2025 voraussichtlich für 1,05 Milliarden Menschen sein.

Hinzu kommt die verheerende Wirkung der Aids-Pandemie. In Afrika leben 13,2 Prozent der Weltbevölkerung, aber 69 Prozent aller HIV-Infizierten der Erde. Aus dieser Prognose erklärt

sich die Vorhersage, dass in Afrika als einzigem Erdteil während des 21. Jahrhunderts die Armut ansteigen wird. Bereits heute leben rund 300 Millionen Afrikaner von weniger als einem Dollar am Tag: Afrika ist die Dritte Welt der Dritten Welt geworden.

An finanzieller Unterstützung aus dem Norden hat es bisher nicht gefehlt, um Afrika auf die Beine zu helfen. Rund eine halbe Billion US−Dollar wurde in den vergangenen 45 Jahren geschickt, das gleicht vier Marshall−Plänen. Pro Kopf der Bevölkerung hat Sub-Sahara Afrika jährlich mit 35 US$/Kopf deutlich mehr (bilaterale und multilaterale) Entwicklungshilfe bekommen als die Entwicklungsländer insgesamt (13 US$/Kopf).

Nur ist das Ergebnis bedrückend: In krassem Kontrast zu den »Entwicklungsländern« Asiens ist der Anteil des sub-saharischen Afrikas am Welthandel, von den Ölexporten abgesehen, gesunken, die Staatsschulden und die Armut sind gewachsen. Gleichwohl sind die meisten afrikanischen Länder wirtschaftlich weiter zurückgefallen. Das Pro-Kopf-Einkommen Sub-Sahara Afrikas war in 2006 im Durchschnitt geringer als in 1970.

Ghana zum Beispiel hatte 1970 mit 250 $US/Kopf ein mit Südkorea vergleichbares Pro-Kopf Einkommen; 2005 betrug es nach Kaufkraftparität noch 11 v.H. des koreanischen Pro-Kopf Einkommens, bzw. heute liegt das südkoreanische Einkommen pro Kopf über dreißigmal höher. 48 afrikanische Staaten bringen es zusammen auf das Bruttosozialprodukt von Belgien. Drei Viertel der Afrikaner leben in Armut, jedes dritte Kind ist unterernährt. Die durchschnittliche Lebenserwartung ist auf 48 Jahre gefallen, Afrikas Anteil am globalen Handel auf knapp ein Prozent gesunken. Pessimisten prophezeien, die nächste Generation werde noch ärmer, kränker und schlechter ausgebildet sein.

Der Kolonialismus hinterließ sicherlich zentralistische, kaum funktionsfähige Staatshülsen, und zerrissene Völker, die für den globalen Wettbewerb nicht gerüstet waren, mit jungen, ahnungslosen Männern an den Schalthebeln. Als die Belgier den Kongo räumten, gab es gerade einmal sieben einheimische Akademiker. Aber kann dies die (alleinige) Ursache für die negative Entwicklung der zurückliegenden 50 Jahre sein?

Zusammenfassen kann man die Kernprobleme im heutigen Afrika:

- Zu hohes Bevölkerungswachstum
- Massenerkrankungen wie Aids, Malaria
- Unterentwicklung, Perspektivlosigkeit
- „Bad governance“, keine funktionierenden Staaten
- Kriegerische Auseinandersetzungen, Bürgerkriege
- Spielball der Großmächte
- Keine Inwertsetzung eigener Ressourcen

- Keine funktionierende Elite
- Korruption
- Verschuldung
- Wirtschaftlich uninteressant für den Rest der Welt:
  - Nur 1 % des Außenhandels der EU mit Afrika
  - Statt Investitionen nur Desinvestitionen
- Keine funktionierende Infrastruktur und Logistik
- Abgeschiedenheit:
  Die meisten sub-saharischen Regionen liegen abgeschnitten von den Küsten wie große unzugängliche Inseln im Inneren des Kontinents - manche sind gleichsam in die Unentdecktheit zurückgefallen. Eine der Folgen sind erhebliche Wettbewerbsnachteile: Einen Container von der amerikanischen Westküste an die Elfenbeinküste zu verfrachten kostet 3000 US-Dollar. Wird er indes in die markt- und wasserferne Zentralafrikanische Republik geschickt, steigt der Frachtpreis auf 13 000 Dollar.
- Extreme Klimaverhältnisse:
  Regenzeiten mit gigantischen Niederschlägen oder langen Dürreperioden

Missglückter Systemwandel und mangelnde Regierbarkeit

Der Kontinent ist auf fatale Weise zwischen Stamm und Staat, Ausgleich und Ausrottung, Modernisierung und Archaisierung hin und her gerissen: In vierzig Jahren Unabhängigkeit hat der Kontinent über 80 Militärputsche erlebt, bei denen über zwei Dutzend Regierungs- und Staatschefs umgebracht wurden. Seit 1970 sind in Afrika mehr als 33 Kriege gezählt worden - Kriege zwischen Staaten, aber vor allen Dingen Konflikte innerhalb der Staaten: Bürgerkriege, Stammesfehden, ethnische Auseinandersetzungen, religiöse Konfrontationen. Konflikte, die jährlich über tausend Tote kosten, tobten in Angola, den beiden Kongos, Eritrea, Äthiopien, Ruanda, Somalia und dem Sudan. Zugleich erschütterten bewaffnete Auseinandersetzungen minderer Intensivität die Länder Burundi, Djibuti, Senegal, Sierra Leone, Tschad und Uganda. Von den weltweit 22 Millionen Flüchtlingen, die aus ihren Heimatländern vertrieben worden sind, leben 8 Millionen in Afrika; weitere Millionen sind Flüchtlinge im eigenen Land. Allein im Ost-Kongo schätzt man die Zahl der Toten durch kriegerische Auseinandersetzungen auf drei Millionen.

Viele afrikanische Krisen und das Leid der Bevölkerung bleiben für die Weltöffentlichkeit fast unsichtbar. Unsere Welt ist CNN-gesteuert. Was ist den Medien nicht ist – ist nicht. Für Journalisten selbst ist die Berichterstattung aus den Krisenherden nicht ungefährlich. Auf eige-

ne – afrikanische – unabhängige Berichterstattung kann selten zurückgegriffen werden. Auch scheint das weltweite Interesse an Nachrichten über diesen schwarzen Kontinent gering zu sein. Es ist der Kontinent der vergessenen Krisen. Jeder weiß, dass es den afrikanischen Kontinent gibt – aber kaum jemand weiß etwas über ihn.

Die Stagnation und Regression der afrikanischen Krisenländer in den 90er Jahren lässt sich maßgeblich aus missglücktem Systemwandel erklären. Die an der Macht befindlichen Herrschaftsregime erfuhren einen erheblichen Legitimationsverlust. Neben internen Gründen (sprich: administrativer Ineffizienz und ökonomischer Inkompetenz) spielte der Druck wirtschaftlicher Globalisierung, der Wegfall der Supermächtekonkurrenz und die zunehmende Konditionalität der Entwicklungshilfe eine wesentliche Rolle. Während ein Teil der Staaten bei den Reformen durchaus Erfolge erzielen konnte, gab es in anderen Ländern Rückschläge bis hin zum Staatszerfall.

Zu den Konfliktursachen zählen:

- Einseitige Rohstoffabhängigkeit und starke Exportorientierung machen es Bürgerkriegsparteien leicht, ihre Kriege zu finanzieren.
- Konflikte in einem Staat können für den Nachbarstaat zentrale Auswirkungen haben. So interveniert z.B. ein Staat im anderen, um eine Rebellengruppe anzugreifen, die sich dort zurückgezogen hat. Darüber hinaus gibt es zahlreiche zwischenstaatliche Verbindungen zum Handel mit Waffen und Rohstoffen. Es findet also eine Regionalisierung der Konflikte statt.
- Ökonomische und soziale Ungleichheiten zwischen Gruppen – seien sie nach Region, Ethnie, Klasse oder Religion unterschieden – können zu kriegerischen Auseinandersetzungen führen. Ungleichbehandlungen können sich z.B. bei Land- oder Schürfrechten, beim Zugang zu öffentlichen Ämtern oder Förderung bzw. Unterdrückung der Sprache äußern.
- Das persönliche Profitinteresse der kriegsführenden Parteien führt zu einer Privatisierung des Krieges: im Zentrum stehen seltener politische Interessen, sondern die persönliche Bereicherung der Warlords. Verstärkt wird dieses Phänomen zudem durch ein Engagement privater Sicherheitsfirmen, die z.T. eng mit rohstofffördernden Unternehmen zusammenarbeiten.
- Korrupte Regierungen als Folge des Kalten Krieges und postkolonialer Einflüsse unterdrücken einerseits brutal die Bevölkerung des Landes, andererseits schaffen sie sich ein Netz von finanziell Bevorzugten. Die Bevölkerung verbindet mit Regierung und Staat auf Grund der Bereicherungen und Willkür wenig politische Hoffnungen. Es fehlt dem Staat an Legitimierung. Deswegen muss er seine Macht durch Gewalt halten. Die Balance aus Bevorzugung und Gewalt ist instabil und kann leicht in Bürgerkrieg münden.
- Über den internationalen globalisierten Markt haben die kriegsführenden Parteien gute

Chancen, die von ihnen kontrollierten Rohstoffe abzusetzen und damit ihre Kriege zu finanzieren. So ermöglichten beispielsweise westliche Ölkonzerne die Weiterführung des Krieges in Angola, weil sie auch in Bürgerkriegszeiten Öl förderten und damit der angolanschen Regierung die nötige Liquidität verschafften.

- Eine als „politisch unkorrekt“ eingestufte Konfliktursache ist auch der in Afrika herrschende „Rassismus“ untereinander.
- Einer der zentralen Gründe dafür, warum Kriege und Konflikte in manchen Regionen Afrikas oft Jahrzehnte anhalten, ist – so seltsam es klingt – der Reichtum dieser Länder. Öl, Coltan, Diamanten, Tropenhölzer und viele andere begehrte Rohstoffe sind der Stoff, aus dem diese Kriege sind. Objekt der Begierde und zugleich Mittel, die Kriege immer wieder aufs Neue zu finanzieren.
- Geschäftemacherei durch Kumpanei internationaler Unternehmen mit afrikanischen Entscheidern. So wurden irrsinnige Projekte in Angriff genommen, wie z.B. in Nigeria: Zwölfspurige Autobahnen, schlüsselfertige Universitäten, ein monumentales Stahlwalzwerk, das bei Ajaokuta aus dem Busch gestampft wurde: Grundsteinlegung 1972, 18 Jahre Bauzeit, geschätzte Kosten 40 Milliarden Mark. Bis heute hat es keine einzige Tonne Eisenerz verarbeitet. Solche „Projekte“ findet man fast überall.
- Der kenianische Ökonom Shikwati sieht eine der Konfliktursachen in den Folgen der Entwicklungshilfe: Sie blähe Staatsbürokratien auf und fördere eine absurde Planwirtschaft. Sie werde zum Kauf von Waffen missbraucht. Sie ermögliche »monströse Projekte, die die Umwelt zerstören und menschliche Tragödien anrichten«. Vor allem aber lähmten die Geld- und Sachgeschenke die Produktivität der Empfängerstaaten und die Eigeninitiative ihrer Bürger.
- Ein zu geringes gut ausgebildetes Bürgertum.

Afrika beherbergte 1998 circa 90 Millionen männlicher Jugendlicher zwischen zehn und 19 Jahren. Bis 2025 wird ihre Zahl auf etwa 150 Millionen steigen. Darüber hinaus sind die 20- bis 30-Jährigen mit zu bedenken, deren Zahl von 123 Millionen sich bis 2025 verdoppeln wird. Die Zukunft dieser jungen Männer ist nicht allzu vielversprechend. Es ist ein Leben in fast unregierbar gewordenen Elendsvierteln der Megastädte, der Wurzellosigkeit von städtischer und ländlicher Armut, ohne rechtes Auskommen. Schon heute ist das einst dicht gewebte Netz der erweiterten Familie brüchig geworden. In manchen afrikanischen Ländern leben 20 Prozent der Kinder und Jugendlichen - Mädchen eher als Jungen - nicht im Haushalt der Eltern. AIDS, eine Seuche der Verwaisung, trägt dazu bei, dass die Zahl der Straßenkinder zunimmt. Sie sind oft unterernährt, in schlechtem Gesundheitszustand, drogenabhängig und Objekt polizeilicher Willkür und der Rekrutierungsanstrengungen der Kriegsherren. In den Elendsvierteln der Städte gehören Kriminalität und Gewalt zum Aufwachsen.

In der Welt der afrikanischen „Gewaltmärkte“ verschärfen sich diese Erfahrungen. Es ist eine Welt, in der Gewalt sowohl ökonomisch und sozial zweckrational als auch Selbstzweck ist. Die Gewaltmärkte, die von Somalia über Liberia bis Algerien reichen, sind ein Lebensraum, der gleichsam die Funktion eines „Leistungszentrums“ erfüllt. Aus Tausenden werden dort diejenigen ausgewählt, die für ein Leben im Zeichen der Gewalt geeignet sind, vom Straßenräuber bis zum Selbstmordattentäter.

Die Grenzen zwischen politischer und ökonomischer Kriegsmotivation sind fließend.

So begründet Ruanda sein militärisches Eingreifen in der Demokratischen Republik Kongo mit Sicherheitsinteressen. Ein Bericht der UN weist der ruandischen Regierung hingegen ein großes Interesse an den Rohstoffvorkommen des Nachbarstaates nach. Diese Mischung aus politischen und ökonomischen Ursachen der afrikanischen Kriege macht die Unübersichtlichkeit aus, die den Konflikten eine Aura der scheinbaren Unerklärbarkeit und damit Unvermeidbarkeit verleiht. Eine Vielzahl beteiligter Akteure vertritt ebenso viele und manchmal wechselnde Interessen. Wer heute noch Freund ist kann morgen auch schon Feind sein, Kriegsgegner werden zu Geschäftspartnern. Mit der exzessiven Rohstoffausbeutung und dem Anwachsen des informellen Sektors hierarchisiert und fragmentiert sich der soziale Raum in vielen afrikanischen Ländern immer weiter. So bietet der Sektor der privaten Sicherheit ungeahnte Möglichkeiten der Entfaltung und Expansion. Afrikanische Regierungen bedienen sich seit den 1990er Jahren verstärkt der Unterstützung durch sog. Privatarmeen (Private Military Companies, PMCs) und privater Sicherheitsdienste, um über gewaltoffene Räume im Inneren des Landes die Kontrolle zu behalten und – oft unter dem Druck internationaler Konzerne – einen reibungslosen Ablauf der Rohstoffausbeutung zu garantieren.

Nach all den Fehlschlägen ist Afrikas Anteil an globalen Direktinvestitionen auf unter zwei Prozent gesunken. Das afrikanische Risiko ist unwägbar geworden: Krieg und Anarchie, kleine Märkte, niedriges Wachstum, hohe Produktionskosten, das allgemeine Ausbildungsniveau so dürftig wie die Kompetenz der Entscheidungsträger - wer wollte da investieren?

Das wird so bleiben, solange wirtschaftliche Reformen nicht durch einen fundamentalen politischen Wandel unterfüttert werden, durch echte Demokratien, stabile Rechtsstaaten, lebendige Zivilgesellschaften. Die Welt zwischen Khartoum und Kapstadt befindet sich in einem wirren Interregnum: Staaten zerfallen, Landkarten werden umgezeichnet, alte Konflikte flammen auf, neue Gewalt entsteht. Historiker vergleichen diese Phase mit den Stürmen, die in Europa die Geburt des Nationalstaates begleiteten. Afrika ist dabei, sich neu zu ordnen, und dieser turbulente Prozess dürfte noch Jahrzehnte dauern. Die Mehrheit der Afrikaner wird derweil in der Schattenwirtschaft überleben, die keine Statistik erfasst.

Afrikas postkoloniale Geschichte scheint die Geschichte eines gescheiterten Versuchs der Modernisierung zu werden.

Notwendigkeit der Entwicklung und Perspektiven

Die internationale Gemeinschaft ist sich einig, dass sich vor dem Hintergrund der fortschreitenden Globalisierung aller Lebensbereiche und der ungerechten Ausgangssituation zwischen Industrieländern und Entwicklungsländern Armut, wachsende Ungleichheit und daraus entstehender Terrorismus zu den Grundproblemen des neuen Jahrhunderts gehören. Sie liegen an der Wurzel vieler anderer globaler Risiken und Gefährdungen. Ein „armes" Afrika mit bankrotten Staaten wird ein Nährboden für Terrorismus sein.

Weltweite Armutsminderung liegt nicht nur deswegen in unserer immer enger verflochtenen Welt auch im deutschen Interesse.

Migration in die EU, auch nach Deutschland, auch in das deutsche Sozialsystem, findet seine Hauptursache in der krassen Kluft zwischen reich hier und arm da. Der senegalesische Staatspräsident Diouff sagte mir bereits 1995: Wenn Europa Afrika nicht nachhaltig unterstützt, wird es nicht zu vermeiden sein, dass sich Millionen Afrikaner nach Europa aufmachen werden, um dort ihr vermeintliches Glück zu suchen. Man stelle sich vor, nur die Hälfte der Afrikaner, die durch das schnelle Anwachsen der Bevölkerung würden – weil es für diese „daheim" kein wirtschaftliches Auskommen mehr gibt – sich Jahr für Jahr auf den Weg nach Europa machen, also etwa 5 bis 10 Millionen Migranten pro Jahr. Keine „chinesische Mauer" könnte diesem Ansturm standhalten.

Um Afrika also Perspektiven für die Zukunft zu geben, muss man den Kreislauf aus Ausbeutung von Ressourcen und Arbeit durch das Ausland oder die einheimische Oberschicht, Schuldrückzahlungen, Gewaltherrschaft lokaler Stammesfürsten, tödlichen regionalen Konflikten und bitterer Armut durchbrechen. Dazu ist der Kontinent auf Hilfe von Außen angewiesen. Insbesondere die europäische Afrikapolitik hinterlässt dabei einen zwiespältigen Eindruck, eher auf den eigenen Vorteil und die eigenen Interessen bedacht, als auf eine tatsächliche Unterstützung Afrikas.

Bemerkenswert ist, mit welchen finanziellen, politischen und personellen Mitteln die EU ihre 12 neuen ost-europäischen Mitgliedsstaaten gefördert und entwickelt hat. Ein regionaler Strukturfonds ausgestattet mit 396 Mrd. Euro, die Übernahme des europäischen Rechtssystems, eine schier unermessliche Beratungskapazität haben aus diesen ehemals kommunistischen Ländern mit teilweise Entwicklungsländer-ähnlichen Rahmenbedingungen hochentwickelte Ökonomien in weniger als 10 Jahren geschaffen. Ein Vorbild für Afrika?

So haben die Afrikaner im Agrar- und Textilsektor komparative Kostenvorteile, werden aber durch Handelsschranken, trotz AKP-Abkommens, vom Wettbewerb in Europa, Nordamerika und Japan weitgehend ausgeschlossen. Allein durch den Agrarprotektionismus verlieren sie pro Jahr geschätzte Exporteinnahmen von 20 Milliarden Dollar - das ist doppelt so viel, wie an Entwicklungshilfe nach Afrika fließt. Die Landwirtschaft wurde, auch wegen dieser Handels-

hemmnisse, in fast allen Staaten des postkolonialen Afrika sträflich vernachlässigt - und damit zugleich die Ernährungssicherung. Die meisten Afrikaner sind inzwischen Subsistenzbauern: Sie erzeugen gerade so viel, dass es zum Überleben reicht, und manchmal auch weniger.

Natürlich ist Afrika kein verlorener Kontinent. Vieles dort ist falsch gelaufen und wird auch in Zukunft noch falsch laufen. Ein ernsthaftes Interesse, diesem Kontinent den Anschluss an die Globalisierung und die Weltwirtschaft zu vermitteln, ist nicht erkennbar. Die Instrumente der Entwicklungshilfe sind begrenzt und reichen bei weitem nicht aus. Es sind drastische Eingriffe in das Staatswesen zahlreicher afrikanischer Staaten erforderlich, wenn diese Staaten wieder Bindung an den Rest der Welt bekommen sollen. Das Verfahren zur Aufnahme neuer EU-Mitglieder ist im Kern ein gehbarer Ansatz. Er basiert auf gegenseitiger Freiwilligkeit, einer klaren Zielsetzung, eines tiefen Eingriffs in den Staat und sein Rechtssystem und natürlich auch der Verfügbarkeit entsprechender Ressourcen.

Für eine nachhaltige Entwicklung Afrikas zum Anschluss an die Weltwirtschaft gilt das Folgende zu beachten:

- Rechtsstaatliche Regeln sind Voraussetzung für eine erfolgreiche Wirtschaftsentwicklung und wichtiger als die vom GATT geforderten freien Märkte. Ohne Staat gelingt keine Wirtschaft.
- Viele afrikanische Staaten sind auch auf Grund der hier geschilderten Umstände nicht in der Lage, ein funktionierendes Rechtsstaatssystem aus eigener Kraft zu errichten. Sie benötigen Unterstützung von außen verbunden mit der Freiwilligkeit und des tiefen Eingriffs in das eigene Staatswesen.
- Viele afrikanische Staaten werden noch auf Jahrzehnte von einer fairen und nachhaltigen Unterstützung, auch Entwicklungshilfe, Budgethilfe, Warenhilfe, von außen angewiesen sein
- Europa sollte für Afrika mehr Verantwortung und Mut übernehmen, und auch vor “stabilisierenden” Eingriffen mit klarem Mandat und klarer Zielsetzung nicht zurückschrecken
- Europa sollte keine Finanzmittel transferieren, deren Verbleib nicht kontrolliert ist
- Die EU sollte ihre eigene Schutzpolitik, wie z.B. ihren Agrarsektor, ändern zu Gunsten der Erleichterung auch mit der EU konkurrierenden afrikanischen Exporterzeugnissen.
- Ausgesuchten afrikanischen Staaten sollte eine viel engere Anbindung an die EU geboten werden, als es das AKP-Abkommen bietet. ZU den Kriterien könnte gehören
  - □ Funktionierende Demokratie
  - □ Funktionierende “Gewaltenteilung”
  - □ Stabile Rahmenbedingungen (Finanzsektor, Infrastruktur, Rechtssystem, Qualifizierung der Bevölkerung u.v.m.

- Teile des EU-Acquis Communautaire, des Europäischen Rechtswerks, könnten auch in ausgesuchten afrikanischen Staaten eingeführt werden, um so eine präferenzierte Assoziation zu ermöglichen.
- Diese Staaten könnten die Rolle von "Lokomotiven" in Afrika übernehmen.
- Es bedarf aber auch eines radikalen Mentalitätswandels, einen neuen Schaffensdrangs eines Großteils der afrikanischen Bevölkerung.
- Ohne risikofreudige afrikanische Unternehmer, gut ausgebildete Arbeitskräfte und eine bürgerliche Mittelschicht bleibt die Marktwirtschaft und eine Teilhabe an der Weltwirtschaft nur ein schönes Wunschbild.
- Eine Überwindung der unsicheren politische Lage, des Missmanagement, der Korruption, des Mangels an qualifizierten Arbeitskräften, der niedrigen Produktivität, der kleinen geschlossenen Märkte, der geringen Massenkaufkraft, der miserablen Infrastruktur, der astronomischen Transportkosten, der fehlenden Rechtssicherheit und Rechtsstaatlichkeit, des fehlenden Finanzsektors – erst wenn all dies abgeschafft ist, lassen sich Investoren blicken, aus dem Ausland und aus dem Inland.

So sollte unser Institut, das ITT, sich zum Ziel setzen, unterstützt mit Stipendien des DAAD und anderer, die Zahl afrikanischer Studenten deutlich zu erhöhen, um so einen Beitrag zur Bildung eines qualifizierten Bürgertums in Afrika zu leisten. Bildung ist eine der prioritären Voraussetzungen, um ein Gelingen jeglicher Entwicklungsmaßnahme in Afrika erfolgreich zu machen. Dem Vorbild anderer Regionen unserer Welt folgend, muss Afrika vornehmlich selbst seine Entwicklung in die Hand nehmen und verantworten. Die Voraussetzungen sind in dem Kontinent reichhaltig vorhanden. Es liegt in der Hand der Menschen dort selbst.

Das Konzept der deutsch-arabischen Studiengänge

Prof. Dr. Matthias Weiter

1. Festlegung der Prioritäten für die deutsch-arabische Zusammenarbeit

Das für die deutsche Entwicklungspolitik zuständige Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ) hat von 2005 bis 2007 vier Gruppen von Fachleuten damit beauftragt, die Konzepte, Aktivitäten und Ergebnisse der letzten drei Jahrzehnte entwicklungspolitischer Zusammenarbeit der Bundesrepublik mit den arabischen Ländern zu beschreiben und zu bewerten. Die Gutachter reisten in der Region, führten Gespräche in Institutionen und werteten Dokumente aus, so auch die *Arab Human Development Reports*. Auf der Grundlage dieser Berichte sowie der Fachgespräche mit den arabischen Partnern anlässlich der jährlichen bilateralen Konsultationen und Regierungsverhandlungen legte das BMZ vier fachliche Schwerpunkte für die zukünftige Zusammenarbeit fest:

- Integriertes Wasser-Ressourcen-Management
- Erneuerbare Energien und Energie-Effizienz
- Wirtschaftsförderung
- Bildungsreform

Diese Festlegung bedeutete keine drastische Veränderung, sondern nur eine Bestätigung und Verstärkung von in den letzten zehn Jahren bereits eingeleiteten Trends: In den siebziger und achtziger Jahren noch waren die Förderung der landwirtschaftlichen Produktion und der Ausbau der Verkehrs-Infrastruktur Schwerpunkte der deutsch-arabischen Zusammenarbeit. Seitdem haben sich jedoch die Rahmenbedingungen deutlich verändert:

Der in der gesamten Arabischen Welt schnell wachsende Wasserverbrauch in den Haushalten, vor allem aber in der Landwirtschaft führten in den achtziger Jahren zu Versorgungsproblemen, die ein effizienteres **Wassermanagement** erforderten, das auch die Abwasseraufbereitung mit einschließt.

- Mit dem Ende des Sozialismus in Osteuropa und der **Globalisierung der Wirtschaft** veränderten sich für viele arabische Länder traditionelle Handelsbeziehungen. Wirtschaftspolitik und Produktionsweisen müssen sich zunehmend am Weltmarkt und an den Folgen immer schnellerer und billigerer Arten und Wege von Kommunikation und Transport orientieren.

- Entwicklung und Globalisierung erfordern die Umstellung auf ein flexibles **Bildungssystem**, damit Arbeitskräfte sich den schnell wechselnden Anforderungen anpassen können.

Dazu sind entsprechend qualifizierte und motivierte Lehrer, ausreichende technische Ausstattung, Zugang zu Information sowie permanente Fortbildungsangebote notwendig.

- Weltweit steigender **Energiebedarf** und abnehmende Öl- und Gasvorräte haben zu steigenden Energiepreisen geführt. Dies beflügelte die Forschung, so dass heute Wind- und teilweise auch schon Sonnenenergie in der Stromerzeugung wettbewerbsfähig geworden sind und gleichzeitig die Folgewirkungen für das Weltklima gemildert werden können. Gleichzeitig kann insbesondere die arabische Region ihren Zuwachs im Energieverbrauch durch den Einsatz Energie-effizienterer Architektur, Baustoffe und elektrisch betriebener Maschinen und Geräte enorm verringern.

Diese Analysen und die daraus abgeleiteten Konsequenzen wurden im Frühjahr 2008 festgeschrieben in dem Konzept „Grundlagen, Schwerpunkte und Perspektiven der deutschen Entwicklungspolitik mit der Region Nahost / Nordafrika“. Das Konzept ist im Internet abrufbar (BMZ 2008).

2. Aus- und Fortbildung sind Voraussetzung für Erfolge in allen Bereichen

Für eine nachhaltige globale Entwicklung sind Verbesserungen der Rahmenbedingung insbesondere auf den Gebieten Klimaschutz, Konfliktabbau, Menschenrechte und Handel erforderlich. Hier bemüht sich die internationale Staatengemeinschaft um Fortschritte und Kompromisse auf internationalen Konferenzen und durch internationale Abkommen.

In der bilateralen entwicklungspolitischen Zusammenarbeit kommen im Wesentlichen die folgenden drei Instrumente zum Einsatz:

- Zuschüsse für die Aus- und Fortbildung von Individuen,
- Entsendung von Fachleuten für Ausbildungs- und Beratungsaufgaben an Institutionen und
- Bereitstellung von Zuschüssen und zinsgünstigen Krediten an Regierungen für die Finanzierung von Investitionen.

In kaum einem Projekt oder Programm der entwicklungspolitischen Zusammenarbeit wird nur eines dieser Instrumente eingesetzt, häufig werde sogar alle drei miteinander kombiniert. Daher sind bei der Programm-Durchführung meist auch mehrere deutsche Organisationen gleichzeitig beteiligt.

Ebenso kommt kaum ein Projekt oder Programm ohne Ausbildungs-Aktivitäten aus. Daher ist Bildung nicht nur in einigen Fällen ein eigener Schwerpunkt in der Zusammenarbeit mit arabischen Ländern, sondern unabhängig davon auch eine Komponente in fast jedem Einzelprojekt.

3. Die neu geschaffenen deutsch-arabischen Studiengänge

Es ist zu erwarten, dass die im Nahost / Nordafrika-Konzept des BMZ festgelegten vier Sektoren Wasser, Wirtschaft, Bildung und Energie auf absehbare Zeit, also sicher für die nächsten zehn bis zwanzig Jahre, die wesentlichen Schwerpunkte der entwicklungspolitischen Zusammenarbeit mit den arabischen Ländern bleiben werden.

Im Rahmen der Einzelprojekte und Programme werden auf der technisch-handwerklichen Ebene Fachleute für die Umsetzung der Maßnahmen aus- und fortgebildet werden. Die arabischen Partnerländer werden nicht umhin kommen, dafür die institutionellen und organisatorischen Strukturen im Bildungssektor ihrer Länder auf die neuen Anforderungen auszurichten, und zwar sowohl in den Inhalten als auch kapazitätsmäßig.

Für die zügige Planung und Umsetzung der Programme in den vier ausgewählten Schwerpunktsektoren werden jedoch auch zunehmend solche Fachleute auf deutscher und arabischer Seite gebraucht, die sowohl

- die fachliche Breite des jeweiligen Sektors überschauen,
- über analytische und konzeptionelle Fähigkeiten verfügen und
- Kommunikations- und Managementtechniken in der internationalen Zusammenarbeit beherrschen.

Das BMZ hat daher aus Mitteln der Technischen Zusammenarbeit den DAAD mit der Aufgabe betraut, für jeden der vier Schwerpunktsektoren einen deutsch-arabischen Aufbaustudiengang zu konzipieren. Damit sollen junge arabische und deutsche Nachwuchs- und Führungskräfte im Hinblick auf die oben genannten drei Ziele qualifiziert werden.

Der erste deutsch-arabische Studiengang, ein **M.Sc. in „Integrated Water Resources Management“,** wird gemeinsam von der University of Jordan in Amman und der Fachhochschule Köln seit 2007 angeboten. Der erste Lehrgang hat im Februar 2009 abgeschlossen.

Der zweite Studiengang, ein **M.Sc. in “Renewable Energy and Energy Efficiency”** beginnt erstmals Juli 2009 und wird gemeinsam von der University of Cairo und der Universität Kassel angeboten.

Der dritte Studiengang, ein **M.A. in Economics** („Economic Change in the Arab Region, ECAR“), wird erstmals ab August 2009 gemeinsam von der Universität Damaskus und der Universität Marburg angeboten.

Der vierte Studiengang, ein **M.A. für den Schwerpunkt Bildung**, ist noch im Planungsstadium. Mit der Ausschreibung unter deutschen Universitäten (mit arabischen Partneruniversitäten) ist noch in 2009 zu rechnen, mit der Vergabe in 2010, und mit dem Beginn des ersten Lehrgangs in 2011.

4. Gemeinsame Charakteristika der vier deutsch-arabischen Studiengänge

Studienablauf

Die Studiengänge sind auf Kleingruppen (max. 10 arabische und max.10 deutsche Teilnehmer) ausgerichtet. Das erste Semester findet jeweils im Winter an einer arabischen Hochschule statt, das zweite im Sommersemester an einer deutschen Hochschule. Im dritten Semester fertigen die Teilnehmer die Master-Arbeit in einem arabischen Land an.

Master-Arbeit

Die Master-Arbeiten sollen möglichst in deutsch-arabisch gemischten Tandems geschrieben werden. Sie sollen aktuelle Themen behandeln, die in fachlich einschlägigen Programmen der deutsch-arabischen Zusammenarbeit relevant sind. Für jeden Teilnehmer soll jeweils ein deutscher und ein arabischer Betreuer aus der Gruppe der Dozenten gewählt werden.

Akkreditierung

Die Akkreditierung als Master-Studiengang erfolgt sowohl in Deutschland als auch in dem arabischen Land, in dem die arabische Partner-Hochschule angesiedelt ist.

Sprache

Unterrichtssprache ist Englisch. Die Arabischen Teilnehmer bekommen zusätzlich Deutsch-Unterricht angeboten. Die deutschen Teilnehmer bekommen zusätzlich Arabisch-Unterricht angeboten.

Interdisziplinarität

In jedem Kurs wird eine Zusammensetzung der Teilnehmer aus unterschiedlichen Fachrichtungen angestrebt, um den Austausch unterschiedlicher Gesichtspunkte und Methoden und zu fördern.

Anforderungen an arabische Bewerber

- Die Bewerber müssen Staatsbürger eines der arabischen Partnerländer der deutschen entwicklungspolitischen Zusammenarbeit sein (derzeit: Ägypten, Algerien, Irak, Jemen, Jordanien, Libanon, Marokko, Mauretanien, Syrien und Tunesien). In jedem Kurs sollten jedoch maximal 3 Teilnehmer aus dem gleichen Land kommen, sofern die ausreichende Qualität aller Teilnehmer gesichert ist.

- Sie müssen mindestens einen guten Bachelor-Abschluss haben.
- Sie sollen mehrjährige Berufserfahrung in einschlägigen arabischen Facheinrichtungen (Regierungsstellen, Fach- und Hochschulen, Unternehmen, Nichtregierungs- Organisationen) haben und – zumindest wenn sie aus dem öffentlichen Dienst kommen – für die Dauer des Studiums beurlaubt werden.
- Sie müssen gute Englischkenntnisse nachweisen.

Anforderungen an deutsche Bewerber

- Sie sollen möglichst einen guten Master-Abschluss haben.
- Sie sollen Praxis-Erfahrung in einschlägigen Facheinrichtungen (Regierungsstellen, Fach- und Hochschulen, Unternehmen, Nichtregierungs-Organisationen) haben.
- Sie sollen Aufenthalts-Erfahrung in arabischen Ländern und zumindest Anfangskenntnisse der arabischen Sprache haben.
- Sie müssen gute Englischkenntnisse nachweisen.

Dozenten

Deutsche und arabische Dozenten werden gemeinsam in Seminaren didaktisch auf die besondere Zusammensetzung und die speziellen Anforderungen der Teilnehmer vorbereitet (Internationalität, Interdisziplinarität, Berufserfahrung, Kleingruppe, unterschiedliche Lerntechniken).

Exkursionen

Sowohl im arabischen Studienland als auch in Deutschland werden die Teilnehmer durch Fachexkursionen in Projekte, Institutionen und zu Fachveranstaltungen an die jeweiligen aktuellen fachlichen Aspekte herangeführt.

Internationaler Beirat

Für jeden Studiengang wird ein Fachbeirat aus Vertretern arabischer, deutscher und internationaler Facheinrichtungen einberufen. Die Mitglieder dieser Beiräte unterstützen die beteiligten Universitäten bei der inhaltlichen und organisatorischen Vorbereitung und Durchführung des Studienganges und bei der Vermittlung von Exkursionen. Sie unterstützen die Teilnehmer bei der Auswahl von Themen für die Masterarbeiten sowie in Karrierefragen.

Finanzierung

Die Finanzierung der Vorbereitung des Studiengangs sowie der ersten drei Durchläufe erfolgt aus Mitteln des BMZ. Danach müssen die beteiligten Hochschulen selbst entscheiden, ob und zu welchen Bedingungen sie den Studiengang weiterführen.

Stipendien

Die ausgewählten arabischen und deutschen Teilnehmer können beim DAAD einen Antrag auf ein Stipendium stellen.

Berufsperspektiven

Die arabischen Teilnehmer sollen von ihren Arbeitnehmern unter dem Gesichtspunkt der Nachwuchsförderung (*young professionals programme*) ausgewählt werden und dürften daher keine Wiedereinstellungsprobleme haben. Die deutschen Teilnehmer werden dazu beitragen, den Fachkräftebedarf bei den in der arabischen Region tätigen deutschen und internationalen Fachorganisationen zu decken. Bei DAAD-geförderten Programmen gilt ein Master-Stipendienprogramm als erfolgreich, wenn sechs Monate nach Studienabschluss 60% der Absolventen einen ihrer Qualifikation entsprechenden Arbeitsplatz besetzen.

Zusammengefasst also sollen diese von deutschen und arabischen Universitäten gemeinsam konzipierten und durchgeführten Studiengänge dazu dienen, dass sich junge Fach- und Führungskräfte aus verschiedenen arabischen Ländern und Deutschland in ausgewählten Fachgebieten für die Intensivierung der internationalen Zusammenarbeit - vorrangig im Arabischen Raum - qualifizieren, sowohl für den öffentlichen Bereich als auch für die Wirtschaft und für Forschung und Lehre.

Quellen

BMZ (2008): „Grundlagen, Schwerpunkte und Perspektiven der deutschen Entwicklungspolitik mit der Region Nahost / Nordafrika“. - http://www.bmz.de/en/service/infothek/fach/konzepte/konzept156.pdf ebenfalls verfügbar in

Arabisch: http://www.bmz.de/en/service/infothek/fach/konzepte/konzept171.pdf

Englisch: http://www.bmz.de/en/service/infothek/fach/konzepte/konzept168.pdf

Französisch: http://www.bmz.de/en/service/infothek/fach/fr/strategies169.pdf)

Informationen zu den Studiengängen:

M.Sc. in „Integrated Water Resources Management: http://iwrm-master.info

M.Sc. in “Renewable Energy and Energy Efficiency”: http://remena.uni-kassel.de

M.A. in Economics („Economic Change in the Arab Region, ECAR“): http://www.uni-marburg.de/fb02/ecar

The EU Water Framework Directive – A Key to Catchment-based Governance

Dr. Fritz Holzwarth

„… I love rivers, carrying ideas as well as goods …"
Victor Hugo, "The Rhine. Letters to a true friend", 1839

The Institute for Technology and Resources Management in the Tropics and Subtropics of the Cologne University of Applied Sciences is involved in manifold activities related to Integrated Water Resources Management (IWRM) with a river basin perspective. The successful Master Programmes reflect the need of capacity building in this field and also the passion of Hartmut Gaese for developing and profiling the Institute. Hartmut Gaese underlines clearly that the often mentioned water crisis is primarily a crisis of governance. So it is more than logic to devote my thoughts about the EU Water Framework Directive as a key to catchment-based governance to him.

Water ignores political and administrative boundaries, rivers, lakes and even groundwater, the hidden vital source of human being, are very often shared by several countries. Worldwide, there are more than 260 transboundary water courses. These international waters and their basins cover 45,3 % of the earth´s land surface, affect about 40 % of the world population, and account for approximately 80 % of global river flow.

There is an urgent need for cooperation, for bridge building among countries and peoples, for a common understanding and for cooperative water regimes. Europe has a long tradition in transboundary cooperation dating back to the early nineteenth century if we are taking the Rhine as a successful example. And Europe also has experiences with a broad variety of over 20 transboundary basins with varying characteristics. Germany shares its four largest rivers with its neighbouring countries: the Rhine with 7, the Danube with 18, the Elbe with 3 and the Odra with2 other states; and we also share the North East Atlantic and the Baltic Sea with a number of other riparians.

All the lessons we had learned in Europe through our cooperation in transboundary river basins had lead to a long and deep discussion process in order to develop in the European Union new comprehensive and coherent legislation for managing waters in river basins. This was not an easy task, taking into account that there are states in the basins being not members of the European Union and that among EU Member States there are different legal, social and economic situations as well as different hydrological conditions.

Let me present two different and interesting European cases:

1. The river Rhine, 1320 km long, 8 countries in the basin; 7 EU Member States and Switzerland. I like to call the Rhine an European Community River with homogeneous economic and social conditions and with an equal level of environmental standards. All countries from the source to the mouth cooperate in an integrated manner through five international transboundary water agreements.
2. The river Danube, 2850 km long, 19 countries – some of them only with very minor parts - with inhomogeneous economic and social conditions and a wide range of environmental standards. Some countries are so-called countries in transition, there are a few accession candidates to the European Union and EU Member States. The Convention on the Protection of the Danube, which covers most of these countries, has a basin wide approach and can be seen as a kind of unifying instrument.

The European Water Framework Directive applies to seven countries in the Rhine basin and to eight out of 14 contracting parties of the International Commission for the Protection of the Danube River. Therefore the key question is: How can the EU Water Framework Directive serve as an European key instrument to achieve catchment-based governance?

If we take the principles of good water governance we have to establish an effective water policy with a clear legal framework and institutional structures for managing river basins including conflict resolution mechanisms. An integrated water resources management is essential and the decision-making processes have to be participatory and transparent. The Water Framework Directive reflects these principle elements.

History of the Water Framework Directive

Early European water legislation began, in a "first wave" with standards for those of our rivers and lakes used for drinking water abstraction in 1975, and culminated in 1980 in setting binding quality targets for our drinking water. It also included quality objective legislation on fish waters, shellfish waters, bathing waters and groundwater. Its main emission control element was the so called Dangerous Substances Directive.

In mid-1995 the European Institutions Commission, Parliament and Council agreed on a fundamental rethinking of Community water policy. Whilst EU actions such as the Drinking Water Directive and the Urban Waste Water Directive can duly be considered milestones, European Water Policy had to address the increasing awareness of citizens and other involved parties for their water. At the same time water policy and water management have to address problems in a coherent way. This is why the Commission developed the new European Water Policy in an open consultation process involving all interested parties.

The Communication on the New European Water Policy was formally addressed to the Council of Environment Ministers and the European Parliament, at the same time all interested parties were invited to react, such as local and regional authorities, water users and nongovernmental organisations (NGOs). Scores of organisations and individuals responded in writing, most of the comments welcoming the broad outline given by the Commission.

Following this wide-ranging consultation of interested parties, including the Brussels Water Conference in May 1996, the Commission presented its Proposal for a Water Framework Directive, with the following main objectives:

- Expanding the scope of water protection to all waters, surface waters and groundwater as well as coastal- and transitional waters,
- achieving "good status" for all waters by a certain deadline,
- water management based on river basins,
- "combined approach" of emission limit values and quality standards,
- getting the water prices right,
- involving the public more closely in order to influence and streamline implementation.

After a long discussion process and a conciliation procedure between the Council and the European Parliament the Directive has entered into force on December 22, 2000 and is now in an advanced status of implementation.

Expanding the scope of water protection

All EU waters are subject to protection under the Water Framework Directive, surface waters and ground water. Unlike previous water legislation, the Framework Directive covers surface water and groundwater together, as well as estuaries and coastal waters. Its purpose is threefold: to prevent further deterioration of, and to protect and enhance the status of aquatic ecosystems; to promote sustainable water consumption based on the long-term protection of available water resources; and to contribute to the provision of a supply of water in the qualities and quantities needed for its sustainable use.

Good status of all waters by a certain deadline

Under the Directive Member States have to ensure step by step that good status is achieved or kept in all waters by 2015 and the following implementation cycles. The Directive foresees some derogations, which have to be justified. For groundwater, good chemical and quantitative status has to be achieved; for surface waters good ecological and chemical status is the objective. Member States has until now established an analysis of the current status of its waters and monitoring programmes for systematically monitoring the quality and quantity of their groundwater and surface waters. At the moment river basin management plans and programmes of measures are elaborated for achieving the required good status.

Water management based on river basins

Waters do not respect neither administrative nor national boundaries. Therefore the Framework Directive sets, based on experiences gained in various regions throughout Europe, the objective of water management based on river basins – as the natural geographical and hydrological unit.

Regions and river basins like e.g. those in the Maas, Scheldt or Rhine basins have served as positive examples for this approach with their cooperation structures and their joint setting of objectives across Member States borders, or in the case of the Rhine, and the Danube even beyond EU Member States.

River basin management

Several member States have already chosen a river basin approach before the Framework Directive like France, but this has not been the case everywhere. For each EU river basin – some several of them international – a "river basin management plan" needs to be established and updated every six years. This plan will have to include an analysis of the river basin's characteristics, a review of the impact of human activity on the status of waters in the basin, and an economic analysis of water use. Groundwater and coastal waters have to be assigned to the most appropriate river basin district. The Directive is also an instrument for the EU to implement the United Nations Economic Commission for Europe Convention on the Protection and Use of Transboundary Water Courses and international Lakes.

Programme of measures

A central element to achieve good status is the establishment of national, but internationally coordinated programmes of measures by the Member States. The starting point for these programmes is the sufficient national water legislation and its full implementation as well as the national transposition and implementation of a range of Community legislation on water and other related environmental issues. If this basic set of measures is not enough to ensure that the goal of good water status is reached, the programme must be supplemented with whatever additional measures are necessary. These might include stricter controls on polluting emissions from industry of agriculture as well as from urban waste water sources, or further measures to improve water ecology.

Emissions limit values and quality objectives

The Directive takes a "combined approach" to pollution control

- limiting pollution at the source by setting emissions limit values, and
- establishing water quality objectives for water bodies.

In each case, the more stringent approach applies.

Water quantity addressed

The Framework Directive is the first piece of Community water legislation to address the issue of water quantity. It stipulates that the programme of measures established for each river basin must aim to ensure a balance between the abstraction and recharge of groundwater. Moreover, all abstraction of surface water or groundwater requires prior authorisation except in areas, where it can be demonstrated that this has no significant impact on the status of the water. These provisions, together with the pricing aspect, will contribute towards protecting water as a vital resource.

Getting the water prices right: Cost recovery pricing

The need to conserve adequate supplies of a resource for which demand is continuously increasing is also one of the drivers behind what is arguably one of the Directive´s most important innovations – the introduction of pricing oriented at "full cost recovery".

Transboundary Cooperation

- River Basins falling entirely within European Community territory:

  The Directive constitutes the obligation for Member States to coordinate across the river basin, aiming at one single river basin management plan: In any case national plans have to be coordinated among each other with regard to the objectives and the respective programmes of measures. If this is not possible Member States have at least to coordinate the plans they have to produce for the part of the river basin covered by their territory.

- River Basins extending beyond the boundaries of the European Community:

  Moreover the Directive also requires the obligation for Member States to coordinate across the river basin, integrating as far as possible third countries as well. There is a clear preference also for one single river basin management plan.

Getting the public involved

Caring for Europe's waters requires more involvement of the broad public, interested parties, non governmental organisations (NGOs). To that aim, the Water Framework Directive requires information and consultation when river basin management plans are established and the promotion of active involvement. To support this aim the Commission will organise a biannual conference in order to provide for a regular exchange of views and experiences in protecting Europe's waters.

Europe's waters are in need of more protection as ecosystems, in need of increased efforts to get them clean or to keep them clean. After 25 years of European water legislation this is a demand not only by the scientific community and other experts, but to an ever increasing extent by citizens and environmental organisations. Let us take up the challenge of water protection, one of the great challenges for the European Union in the new millennium.

Lessons to learn from the Water Framework Directive

Even in Europe - if you take the two examples from the beginning, the Danube and the Rhine - we have a broad variety of circumstances and the diverging conditions require appropriate common solutions. The key lesson underlines, there is no "best way" for cooperation or planning for all international river basins. The Water Framework Directive sets up the frame for river basin management in the European Union, but at the same time it gives the EU-Member States the necessary flexibility to develop adapted solutions according to the specifics in the various river basins.

Another aspect has to be underlined. EU Member States are acting in international river basins as – you can call it- legally and politically integrated states. It is obligatory for Member States to transpose into national law and to implement the Directive within fixed timeframes. The results have to be reported to the European Commission and it will check if the Directive is fully implemented by Member States according to the Directive. If not sufficiently implemented the Member States are brought to the European Court of Justice in Luxembourg with drastic consequences in case of a second judgement. Germany for example would have to pay around at least 750.000 Euro per day until the implementation is in line with the Directive.

You have to find consensus and acceptance on the basis of a practical structure to ensure enough time for discussions, confidence building, transparency and even more the political commitment, which is essential for a successful transboundary cooperation. We can already identify lessons learnt deriving from the development process of the European Water Framework Directive, which can apply to the cooperation in other transboundary river basins and lakes. There is a variety of approaches, which should be selected and used on a case-by-case basis.

Political commitment

The road to the Water Framework Directive endeavoured clearly that sustained political commitment and broad based public support are crucial to achieve success in the development and implementation of cooperative river basin management programmes. Measures should be taken to support interested governments to develop political commitment and to work through non-governmental organisations and other parties to create public support. Cooperative programmes should be designed and undertaken in close coordination and with the full support of national and local level political leaders. An expanded base of support by political leaders is important to achieve long-term objectives that often go beyond the tenure of individual politicians.

Spirit of cooperation

Even among European Union Member States in transboundary river basins a spirit of cooperation is vital for a successful cooperation. This requires the involvement also of other than

the European Union institutions and of individuals in these processes to commit themselves to working with others in a flexible and open manner on a sustained basis. The process begins with information sharing and joint objective setting among the cooperating institutions and organisations. The importance of establishing and maintaining a "spirit of cooperation" on a sustainable basis cannot be over-estimated.

Legal Frameworks

Legal instruments to some extent are essential, but the process of their development is as important as their substantive content. An early agreement without being legally binding is not enforceable or sustainable. Also with regard to this issue, there is no blueprint for an effective legal framework for cooperation on transboundary waters. As a general rule, building confidence and nurturing cooperative action will rely on the security that a legal agreement can provide. In some cases, particularly where issues – such as water quality – are causing no conflicts, conventions have been developed early in the cooperative process. In other cases, particularly where water scarcity puts water allocation at the centre of the debate, agreements will be much harder to reach, requiring a high level of commitment and trust. Instruments such as agreed minutes and memoranda of understanding allow expressions of commitment, and create enabling conditions for collaboration, without an internationally binding agreement.

The "framework agreement," often based on the principles of the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses (1997, not in force yet), is an emerging instrument in several regional economic blocks, which defines broad commitment for cooperation. The framework agreement model has great relevance for transboundary waters, where early commitment to cooperation is essential but details of cooperative arrangements need time and dialogue.

In essence, a sound legal framework is important; however, a well designed agreement should be anticipated to take a reasonable amount of time to prepare, negotiate, sign and ratify.

Joint Bodies

Both formally and semi-formally established joint bodies countries can provide an important forum for working together on common and sometime difficult questions. There are a lot of examples in the whole world, like international river basin commissions.

Cross-Sectoral Policies and Planning

To achieve programmatic goals in the short and long term, cross-sectoral policies and planning approaches at the regional, national and local level should be established. The ecological dimension needs to be fully integrated into the design of cooperative programmes to obtain the

maximum benefits for these values with the least cost. This requires that planning processes fully examine these factors and that specialists are involved in design and implementation of activities.

Formation of Partnerships, Role of Stakeholders, Public participation

Cooperation is a political and technical process that requires participation of a variety of parties. The role of experts is crucial in programme planning and implementation. Development and implementation of cooperative management programmes benefits from the involvement of broad-based expertise.

Stakeholders should be actively involved to allow them to identify existing and potential issues and measures for environmental management and locally based monitoring. Provision should be made for community-based organisations and NGOs to express their views and to undertake specialized activities.

Working together on a continuous basis is as an important element of the success of cooperation. This contributes significantly to the openness between parties and facilitates exchange of information on a formal and informal basis. Public participation should be viewed as a continuous process in the establishment and implementation of programmes, projects and activities.

Reliable Data, Monitoring Programmes

There is a consistent need for reliable data, of a variety of types, which can be shared without restriction, in accessible form and in a timely manner. Credible information is a critical instrument in developing and maintaining political and public interest and support. Jointly established and implemented monitoring programmes are important elements of transboundary river basin programmes. They are more cost effective and provide higher quality results. Joint monitoring programmes allow data to be easily compared and verified, constitute a mechanism for date transfer among stakeholders and decision-makers, and introduce incentives for efficient and adequate monitoring requirements, avoiding unnecessary data collection. Actions should be taken to improve the timely exchange of information between cooperating parties. Problems with dissemination hinder the ability to undertake planning and management activities and undermine the development of trust between cooperating parties.

Sharing Knowledge

Information acquisition and sharing is a fundamental and critical issue in the development of transboundary waters. Where management of international water resources is concerned, knowledge is power. Without knowledge, riparian states are extremely nervous about threats to sovereignty, especially when another riparian (particularly, but not necessarily, upstream) is

deemed to have that knowledge and is therefore "powerful". It is in the interests of both riparian states to increase the parity of skills and information of the concerned parties. Knowledge sharing has been very important to the success of cooperative activities in the river basins within the European Union. This has included provision of information to decision-makers, management, scientific bodies and the public.

Downstream Linkages to Estuaries and Coastal Zones

Increasing attention should be given to the implications of current and proposed water resources development strategies on estuaries and coastal zones. At the heart of transboundary river basins management is the strong and complex hydrologic linkage between freshwater management, coastal and marine resources, and environmental and socio-economic conditions in these areas, which are used intensively worldwide – an estimated 70 percent of the population in developing countries lives in the coastal zone.

Terrestrial, coastal and marine environments should be recognized as a management continuum. This approach mandates that measures be taken on a routine basis to support coordination of planning, management and monitoring activities among upstream parties. The very sensitive and fragile nature of coastal ecosystems, especially the coastal lagoons and major deltas, should be taken into account at all levels.

Transboundary Groundwater Resources

Growing demands for water in many areas will increase pressure to undertake activities for integration of groundwater resources into what traditionally have been programmes focused on surface water. Addressing the management of groundwater will require to have access to groundwater management specialists and the development of date collection and monitoring programmes in river basins.

In sum, taking into account the experiences deriving from EU Water Framework Directive, they can serve as a key to catchment-based governance. After all you have see water as a catalyst for cooperation instead of becoming a source of potential conflicts. If we take once more the Rhine, I like to close with a quotation from Alfons Paquet: "A landscape like that of the Rhine … bears the dream of its ideal form uniting nations as a seed in itself" (1923).

Wastewater recycling and reuse in Jordan: An option or a must?

Prof. Dr. Manar Fayyad

Introduction

Jordan is an arid to semi arid country with total area of approximately 89,400 km^2 extending from Syria border in the North to the Red Sea in the South, and from Jordan River border with Palestine and Israel in the West to the deserts of the East bording Iraq and Soudi Arabia.

The highlands east of the Jordan Rift Valley rise to elevate for more than 1000 m Above Sea Level (ASL) in the north at Ajlun and Belqa, and to more than 1200 m in Shoubak and Ras El Naqab areas. The width of this zone ranges from 20 to 50 km and extends from the Yarmouk River in the north to Aqaba in the south. These elevations drop gradually to the plateau in the east, but more sharply to the rift valley in the west.

Jordan can be classified as a semi-desert area. Only the highlands enjoy a Mediterranean climate. Summer's maximum temperatures average is 32° C for the highlands and 38° C for the Jordan Valley and the eastern deserts.

Water Resources

Jordan is classified among the first four poorest water countries in the world. Jordan shares some of its most important water resources with its neighboring countries. These resources form a large percentage of the presently exploited water resources, which the country depends on for meeting present and future water demand.

One of the most important shared water resources is the Jordan River system. Other important shared water resources include the groundwater resources of north Jordan (Azraq, Yarmouk and Amman Zarqa basins), where a large percentage of the natural recharge occurs in the Syrian territories. Also Jordan shares the Disi aquifer with Saudi Arabia in the south.

Water resources in Jordan consist of surface and ground water resources and treated wastewater used in irrigation. Renewable water resources are estimated at about 940 MCM per annum, 276 MCM per year ground water and 693 MCM per year surface water. An additional 143 MCM per year is expected to be available from fossil aquifers and 50 MCM from brackish aquifers after desalination. Available treated wastewater for irrigation is about 73 per year.

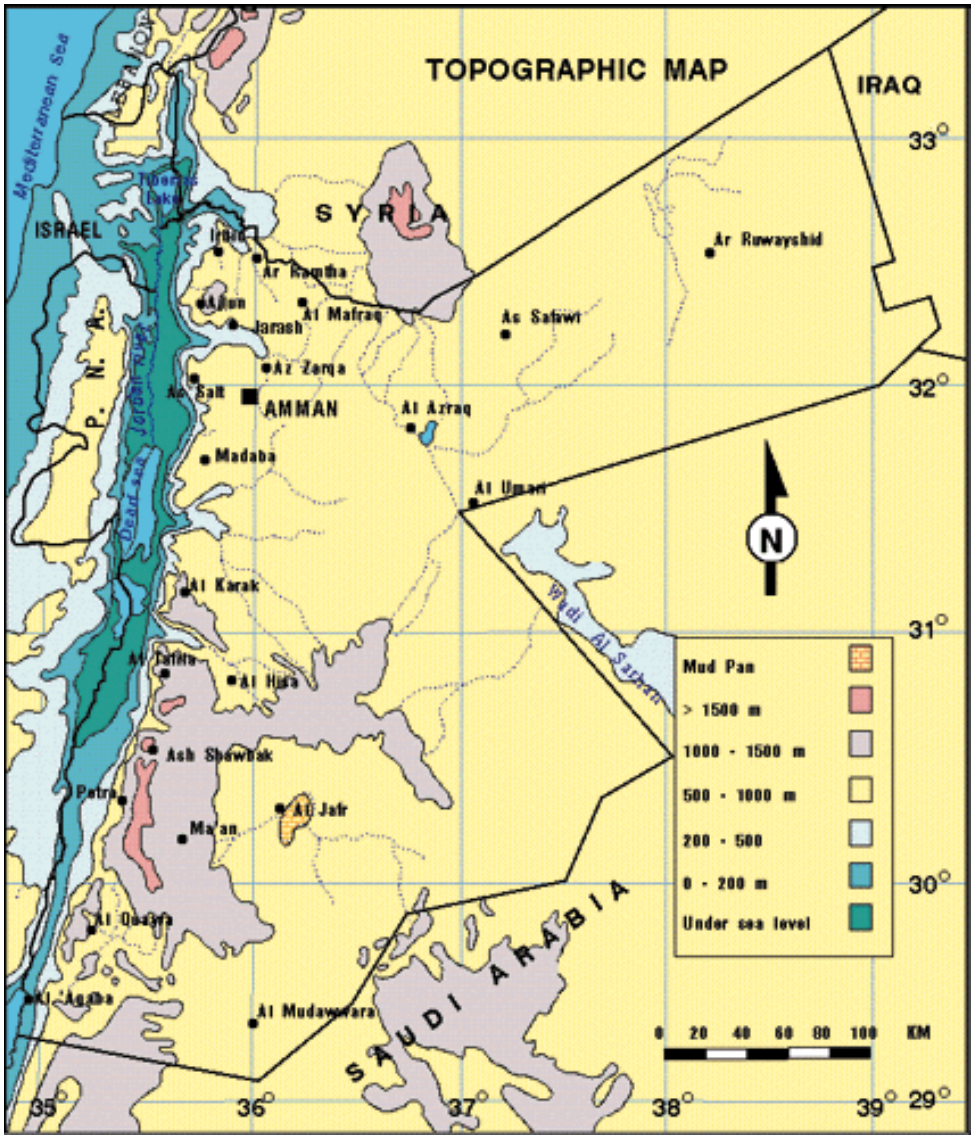

Figure 1: Map of Jordan

Water Use and Demand

Projected future water supply available from all sources is shown in table1. The significant features are the large increase in utilization of surface water from Jordan and Yarmouk rivers, the reduction in the rate of renewable ground water extraction, the development of brackish and fossil groundwater resources, and the increase significance of reclaimed wastewater.

Irrigation water demand in Jordan depends on the cropping pattern implemented, cropping intensity, soil types, climates and irrigation methods used.

Irrigation accounts for almost 66 % of all water use. Farms in the highlands are irrigated by groundwater from private wells. Highland irrigation expanded and uses about 60 % of ground-water.

Table 1: Past, present and projected available water supply in Jordan in MCM.

Source	1990	2000	2010	2020
Surface	324	375	505	505
Renew. Groundwater	434	407	325	285
Fossil Groundwater	63	61	143	143
Recl. Wastewater	35	74.6	177.8	265.3
Brackish Water	0		15	50
Peace Treaty	0	30	50	50
Lower Jordan	0	0	30	30

Municipal demand is growing rapidly at 7.4 percent per annum. Average consumption is 120 L/cap.day, the unaccounted for water constitutes about 45% due to leakages and administrative water losses.

Industry consumes around 5 % of all water use. Because of the unreliability and relatively high cost of public water supplies, many industries install their own private wells to reduce cost and improve reliability. Table 21.2 shows the actual and projected water balance in Jordan.

Table 2: Actual and projected water balance in Jordan (1998-2020) in MCM

Year	Municipal	Industrial	Irrigation	Total Actual	Total Requirement
1998	236 297	39 45	623 863	898	1205
2005	283 382	80 81	679 858	1042	1321
2010	387 434	99 99	764 904	1250	1436
2015	470 518	119 122	693 897	1283	1536
2020	524 611	136 146	627 890	1287	1647

Status of wastewater treatment

Volumes of wastewater

In a country like Jordan where water resources are scarce and traditional water supply resources are being stretched to their maximum limits, using non-conventional water resources like treated wastewater is an obligatory issue.

Treated wastewater generated at seventeen, existing wastewater treatment plants is discharged into various water courses and flows to the Jordan Valley where it is used for irrigation. About 73 MCM of treated wastewater are effectively discharged today into the watercourses or are used directly in irrigation. Table 3 shows the expected treated wastewater quantities till 2020 and the reuse sites.

Table 3: Expected Treated Wastewater Quantities

WWTP	Expected quantities in MCM at Year				Reuse Site
	1996	2000	2010	2020	
As-Samra	46.3	55	110	174	King Talal dam, Zarqa River Basin, fields around WWTP, As-Samra East, Al-Hashemiyah University
Aqabq	2.1	3	4	4.5	Around WWTP, Airport Highway
Ramtha	0.5	0.7	1.9	2.5	Around WWTP
Mafraq	0.7	1	1.3	1.7	Around WWTP
Madaba	0.8	1.2	2.7	3.6	Around WWTP
Ma'an	0.5	0.7	1	1.3	Around WWTP
Irbid	2.8	1.6	4	4	Jordan River and Ghor in near future
Jarash	0.6	0.6	1	1.3	King Talal Reservoir
Kufranjeh	0.4	0.6	0.7	1	Around WWTP, Jordan river
Abu-Nusier	0.4	0.6	2	3	King Tala Reservoir
Salt	1.3	1.2	3.5	5	Wadi Shuieb and Shuieb Dam
Baqa'	2.4	3.65	5.4	7.3	King Tala Reservoir
Karak	0.35	0.5	0.8	1	Wadi Karak
Tafielah	0.3	0.4	0.7	1	Around WWTP and Wadi Tafielah
Fuheis/Mahs	-	0.4	0.7	1	Around WWTP
Wadi Asir	-	0.4	1.6	2	Around WWTP
Wadi Hassan	-	-	0.6	0.6	
Wadi Mousa	-	0.5	1.25	1.8	Around WWTP
Wadi Al-Arab		2.2	6	8.4	
South Amman*	-	-	12	1.8	Around WWTP
Nau'r*	-	0.4	1.1	1.9	Kafrien Reservoir
Ghor 1,2,3	-	-	10.6	12.4	Ghor Site
Wadi Al-Shallaleh	-	-	5	8	Ghor Site

** WWTP under study and construction*

Methods of wastewater treatment

In Jordan a diverse range of wastewater treatment plants exist varying from conventional treatment methods and wastewater stabilization ponds in large communities to simple treatment technologies in small communities.

The characteristics of wastewater in Jordan are somewhat different from other countries. The average salinity of municipal water supply is 580 ppm of TDS, and the average domestic water consumption is low. This results in very high organic loads and in a higher than normal salinity in wastewater. This is particularly applicable to wastewater treated in waste stabilization ponds, where part of the water is lost by evaporation, thus increasing salinity levels in the effluents. In addition, high organic loads impose problems where the plants become biologically overloaded with only a portion of their hydraulic theoretical loads.

Because of the low level of industrial discharges to sewage treatment plants, wastewater in Jordan is comparatively low in toxic pollutants such as heavy metals and toxic organic compounds. It is estimated that only 10 % of the biological load comes from industrial discharge.

Uses of Reclaimed Wastewater

In arid countries like Jordan, there is competition between domestic, industrial and agricultural demands on water resources, due to population growth; priority is given to the domestic use. Higher return value of the industrial use than those of the agriculture; sometimes a priority to the industrial demand is given. But these waters are not completely lost from the agricultural point of view, because the effluents can be reused for irrigation in the form of wastewater. However, adequate reuse is a key issue.

At the national level, the total production of treated wastewater is about 73 MCM as of 1999. Nearly 95 % of this quantity is used in agriculture; about 3 % for groundwater recharge and 2 % for industrial uses. This practice is a result of the government policy so as to conserve higher quality water for domestic, tourism , and industrial uses.

Historically, the indirect reuse of wastewater effluent has been practiced in Jordan for years, as it has been discharged into the main wadis and mixed with the surface flow. Farmers along the banks of these wadis used to pump water or direct the flow of the wadis and reuse the flowing water for unrestricted irrigation. Natural recharge to aquifers takes place through wadis beds. The direct and controlled reuse of treated effluent in Jordan has been increasing since 1985. The government of Jordan has introduced new legislations on effluent quality to control its use so as not to endanger public health and to protect the environment. It is mandatory that all treatment plant projects must include a fully designed and feasible reuse scheme. Table 4 gives a brief description of reuse schemes that are currently in operation. Zarqa River Basin Scheme is the largest reuse system in operation in Jordan. There are four treatment plants located in the basin that discharge its treated effluent to Zarqa River where it is located downstream at King Talal Dam and used for restricted irrigation in the southern section of the Valley.

Table 4: Direct Reuse Area in Jordan

	Planted area (ha)	**Crop's**	**Excess effluent Flow**
As-Samra	300	Olive, forest, fodder	King Talal Dam (KTD)
Aqaba	150	Forest, some olive trees	None
Ramtha	50	Forest, barley, sudan grass, alfalfa	None
Mafraq	25	Forest, fodder crop	None
Madaba	60	Forest, olive, fodder, flowers	None
Ma'an	7	Forest, olive, ornamental trees	None
Irbid	0.5	Forest, ornamental trees	Jordan River
Jerash	-	-	KTD
Kufranjeh	7	Forest, olive, sudan grass, alfalfa	Wadi Kufranja
Abu-Nusier	0.5	Forest, olive	KTD
Salt	-	-	Wadi Shuieb
Baqa'a	-	-	KTD
Karak	3.5	Olive, ornamental trees	Wadi Karak
Tafilah	1	Olive, fruit trees	Ghor Fifa
Fuhais/Mahas	24	Forest, fruit trees	None
Wadi Essir	15	Forest, fruit trees	None
Wadi Al-Arab	-	-	Jordan River
Wadi Musa		-	None
Wadi Hassan			None
South Amman	Wastewater treatment plants under study and construction		
Nau'r			
Ghor 1,2,3			

Industrial water from the two major industrial cities (Sahab and Al Hassan) is treated separately and is used for on-site irrigation. Scattered industries like the yeast and paper factories that are not connected to the domestic wastewater sewerage system, are using their industrial effluent for on-site irrigation. The effluents of hazardous industries like paint, batteries, chemicals and pharmaceuticals are disposed through evaporation or incineration. Phosphate mining and processing is one of the main industries in Jordan, which consumes about 20 MCM of water. Recently, the processed water has been recycled after settling and filtration. Also, the effluent of the treated plants of Amman Airport and Al-Hussein City are used for irrigation of grasses, green areas and forest trees in the vicinity of the two sites.

Irrigation Methods

The irrigation practices used in the early stages of irrigated agriculture were basin and furrow or other overland methods. Since the 1990s these systems have been replaced by new technologies.

In the Jordan Valley , which is the main irrigated agricultural land in Jordan, water from the King Talal Reservoir, is distributed through a network of underground pressure pipes and delivers between six and nine L/s for twenty four hours, three times a week to each farm unit. Due to the constraints placed on the Jordan Valley Authority (JVA) by the amount of water available, the quantity of water delivered to the farms is restricted. Because of that, irrigation efficiency is a vital issue. Drip irrigation constitutes more than 70 %. There are many studies being implemented to mange demand in agriculture, one of which is to reconsider tariff which is now very low for irrigation water.

Guidelines and Regulations in Jordan on Wastewater Recycling and Reuse

Ministry of Water and Irrigation, together with the Ministry of Health and the Department of Standards and measures have issued regulations and standards that are used to implement wastewater management policies. These regulations cover collection of sewage, wastewater treatment process and effluent disposal .Discharge of industrial and commercial wastewater into sewerage system is strictly prohibited unless such effluents comply with standards of domestic wastewater. All house owners or leaseholders residing in an estate, which is served by a sewerage system network, are encouraged to connect to it.

The discharge of surface runoff water or storm water into the sewerage system networks is strictly prohibited. The regulation and standards for the quality of effluent, its disposal and reuse are not well established. Sometimes, tertiary treatment of wastewater including ozonation or chlorination is imposed before the effluent is discharged.

To protect public health and to prevent the environment from pollution, national standards for treated sewage water quality have been adopted and enforced . These standards are presented in Tables 5 and 6. The major feature of these standards is to control application of treated sewage water in irrigation of fresh vegetables , especially those that are eaten raw. In addition, utilization of treated wastewater becomes more restricted when used to irrigate food rather than feed.

Table 5: Allowable Limits for reuse in irrigation

Allowable limits per end use				
Parameter	**Unit**	**Cooked Vegetables, Parks, Playgrounds and Sides of Roads within city limits**	**Fruit Trees, Sides of Roads outside city limits, and landscape**	**Field Crops, Industrial Crops and Forest Trees**
		A	**B**	**C**
Biological Oxygen Demand	mg/l	30	200	300
Chemical Oxygen Demand	mg/l	100	500	500
Dissolved Oxygen	mg/l	>2	-	-
Total suspended solids	mg/l	50	150	150
pH	unit	6-9	6-9	6-9
Turbidity	NTU	10	-	-
Nitrate	mg/l	30	45	45
Total Nitrogen	mg/l	45	70	70
Escherishia Coli	Most probable number or colony forming unit/100 ml	100	1000	-
Intestinal Helminthes Eggs	Egg/l	< or = 1	< or = 1	< or = 1

Table 5. Guidelines for Reuse in Irrigation

Group B			
Fat And grease	FOG	mg/l	8
Phenol	Phenol	mg/l	<0.002
Detergent	MBAS	mg/l	100
Total Dissolved Solids	TDS	mg/l	1500
Total Phosphate	$T\text{-}PO_4$	mg/l	30
Chloride	Cl	mg/l	400
Sulfate	SO_4	mg/l	500
Bicarbonate	HCO_3	mg/l	400
Sodium	Na	mg/l	230
Magnesium	Mg	mg/l	100
Calcium	Ca	mg/l	230
Sodium Adsorption Ration	SAR	-	9
Aluminium	Al	mg/l	5
Arsenic	As	mg/l	0.1
Berelium	Be	mg/l	0.1
Copper	Cu	mg/l	0.2
Floride	F	mg/l	1.5
Iron	Fe	mg/l	5.0
Lithium	Li	mg/l	2.5(0.075 for citrus crops)
Manganese	Mn	mg/l	0.2
Molibdinum	Mo	mg/l	0.01
Nikel	Ni	mg/l	0.2
Lead	Pb	mg/l	5.0
Selenium	Se	mg/l	0.05
Cadmium	Cd	mg/l	0.01
Zinc	Zn	mg/l	5.0
Chrome	Cr	mg/l	0.1
Mercury	Hg	mg/l	0.002
Vanadium	V	mg/l	0.1
Cobalt	Co	mg/l	0.05
Boron	B	mg/l	1.0
Cyanide	CN	mg/l	0.01

Conclusions and Recommendations

Based on the previous discussion, the following conclusions and recommendations could be made:

- Treated wastewater effluent is considered a water resource and its use is a must in water scarce countries like Jordan.
- The depletion of renewable water resources, the high cost of developing additional resources and the increasing demand on limited water supply in Jordan suggest that wastewater reuse must play a more important role in supplementing conventional resources in the future.
- The treated effluent should be monitored and should comply with the guidelines and standards set for different uses.
- Priority shall be given to agricultural reuse of treated effluent for unrestricted irrigation. Blending of treated wastewater with fresh water is suggested to improve quality where possible.
- Crop nutrients requirement shall be determined taking into consideration the prevailing effluent quality. Overuse of nutrients shall be avoided.
- Accumulation of heavy metals and salinity build up in the soil irrigated with treated effluent should be monitored. Irrigation management should be practiced to guarantee sustainable use of treated effluent in irrigation .
- Farmers shall be encouraged to determine the rate of water application needed for different crops, taking into consideration the value of nutrients in the treated water and other parameters.
- Farmers shall be encouraged to use modern and efficient irrigation technologies. Protection of farm workers and of crops from pollution should be ensured.
- Treated effluent quality should be monitored and users be alerted to any emergency causing deterioration of the quality so that they will not use such water unless corrective measures are taken.
- Studies should be conducted and projects designed and implemented to store the excess treated wastewater in surface reservoirs or in groundwater reservoirs through artificial recharge techniques.
- A comprehensive feasibility study for any reuse project shall be made. Factors should include crop type, irrigation method, soil type and health and environmental aspects.
- The water resources situation is going to get worse; the demand for quality water for domestic and industrial needs is going to grow, while the prospect for improvements in supply are very limited. Inevitably this means that the water for irrigation will include an ever-growing proportion of treated sewage effluent. The Jordan case is probably typical of other countries in the region and of arid countries worldwide. Improved technology can certainly buy us time but, with the present state of knowledge, the long-term prospects are indeed a cause for concern.

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Recharge estimation based on lysimeter drainage rates in the Guarani aquifer outcrop zone

Prof. Dr. Edson Wendland; M. Eng. Alessandra Troleis da Cunha

Introduction

Located in South America between parallels 12º to 35º South and meridian 47º to 65º West, the Guarani Aquifer is one of the largest transboundary aquifers in the world, extending from the Parana sedimentary basin to the Chaco-Parana basin. The aquifer has an estimated surface of 1.2 million km², 840,000 km² of which lie in Brazil, 225,500 km² in Argentina, 71,700 km² in Paraguay and 58,500 km² in Uruguay. Guarani Aquifer is the formal definition of the aquifer composed by clayey sandstone of the Triassic period (245 – 208 million years) – Formations Pirambóia and Rosário do Sul, in Brazil, Buena Vista, in Uruguay - and by sandstone of the Jurassic period (208 – 144 million years) – Formation Botucatu, in Brazil, Misiones, in Paraguay and Tacuarembó, in Uruguay and Argentina. Figure 1 presents schematically the aquifer extension (delimited by a red line) inserted in the Prata watershed (delimited by a black line).

The Guarani Aquifer System (SAG) shows mean porosity of 15-20% and mean thickness of 250 m, being confined in 90% of the area by a thick basalt layer, which grows up to 1,500 m thickness (Rocha, 1997). Apparently the outcrop zones of the system constitute the main recharge area. Rebouças (1976) estimated the permanent reserve of the SAG to be 48,021 km³ with 160 km³/a direct and indirect recharge for the Brazilian portion.. Rocha (1997) presents a reviewed estimation of 37,000 km³ permanent reserve and 160 km³/a total recharge for the whole aquifer area.

Aiming for an efficient management of water resources, hydrologic engineering tries to quantify each process involved in the hydrologic cycle. However, some processes can hardly be measured making the water balances sometimes unreliable. Although the idea is not new (Kitching et al., 1979), the aquifer recharge estimation related to infiltration of exceeding water precipitation still motivates scientific investigations (e.g. Scozzafava e Tallini, 2001, Jocson et al., 2002, Otto, 2002, Weinzettel et al., 2002). The used techniques vary from estimations based on theoretical water balances up to measurements in lysimeters and observation wells.

In this work the recharge rate at the outcrop zone of Guarani Aquifer for São Carlos area was estimated based on data measured on a lysimeter and through the analysis of theoretical infiltration concepts. The reliability of theoretical methods for evapotranspiration estimation could also be evaluated through comparison with the obtained experimental data.

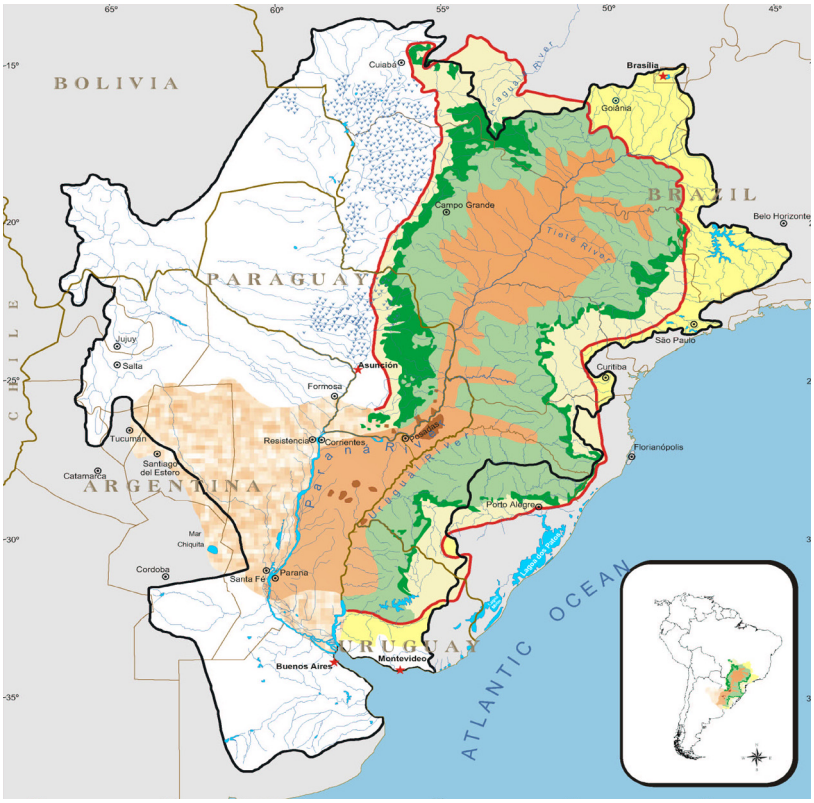

Figure 1: Schematic representation of the Guarani Aquifer System (delimited by a red line) inserted in the Plata watershed (delimited by a black-line) (OAS/GEF, 2001)

Experimental Array

The present study (Cunha, 2003) was developed in an outcrop region of the Botucatu Formation. A lysimeter was assembled at the Hydrometeorologcal Station at the Center for Water Resources and Applied Ecology (CRHEA/EESC/USP) located at 22º11" South, 47º58" West and altitude of 733 m over sea. The equipment consists on an impervious tank with an exposition area of 3.6 m² (1.5 m x 2.4 m) and 1.5 m depth. It is supplied with a drainage system consisting of 2 independent pipes of 2", positioned in the tank basement (figure 2). Each pipe is connected to 3 further draining lines embedded in a gravel bed at 1.5 m depth. The lysimeter was filled with recent superficial sandy soil, which typically covers the Botucatu outcrops. Natural grass was used to cover the soil, in order to reproduce the vegetation observed in the region.

The lysimeter characterizes a closed system, which does not allow superficial and subsurface losses. In order to compare the moisture movement in the experiment with real conditions at the field, tensiometers were installed in the lysimeter and in the neighborhood, where the soil for the experiment was collected. The tensiometers were installed at the same depth of 0.20 m, 0.50 m, 0.80 m and 1.10 m in the lysimeter and in the reference soil.

The drainage study was performed under natural precipitation conditions. The collected amount of infiltrated water was systematically measured daily between January and December 2002. In the rainy period the measurement was performed in the graduated collecting tank. In the dry period or in the period with low precipitation, a graduated pipe and collecting gallons were used.

Data of matrix suction in the lysimeter and in the field were collected three times a week.

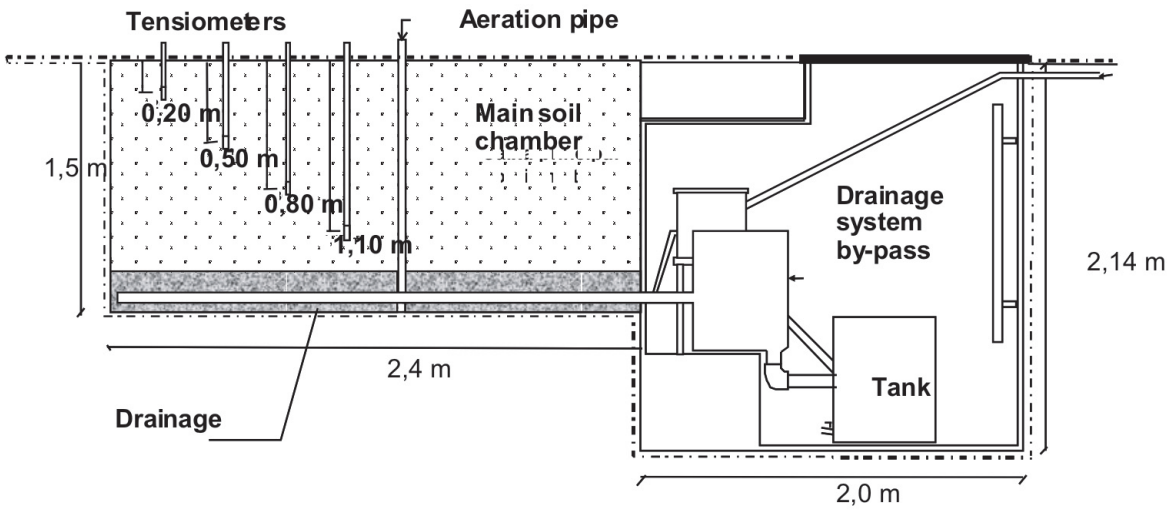

Figure 2: Schematic view of the lysimeter

Result and Discussion

In figure 3 the cummulated precipitation and drainage for two successive days in the month January are presented. A good correlation between both curves can be observed, indicating that the travel time through the soil column is of about two days. Lower precipitation rates do not percolate immediately through the soil column as observed in the period between days 13 and 20.

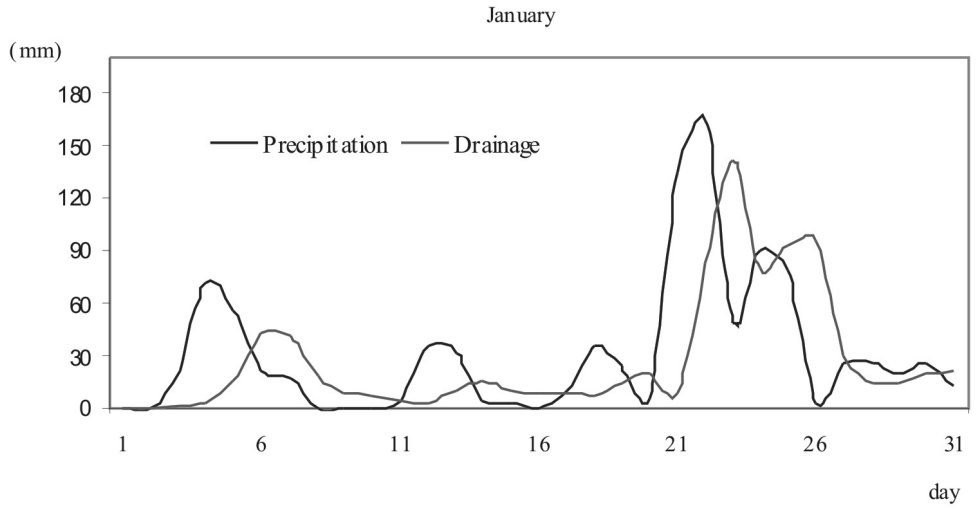

Figure 3: Precipitation and drainage cumulated for two successive days for January (rainy period).

Figure 4 shows monthly values of precipitation and drainage in the lysimeter. In the period between January and December, a total of 788.4 mm drainage was observed for a precipitation of 1416.9 mm. This relation of 55.6% represents the maximal recharge potential for the Guarani Aquifer, in the São Carlos region. Of course, the real recharge will be lower, since in the lysimeter the process of subsurface loss and drainage by rivers do not occur.

Figure 5 shows cumulated precipitation and drained volumes measured throughout the year. Following the graphic, in the initial period of observation, from January to March, both curve inclinations are similar indicating a strong correlation between precipitation and drainage, which characterizes a continuous contribution to recharge. In the period from May to October, the declivity of the drainage curve is zero, showing that there is no contribution to direct recharge of the aquifer. In this essentially dry period, the precipitation is not enough to supply the moisture deficit in the soil in order to allow percolation to the deeper layers of the system. Collection of infiltrated water by the drainage system at 1.50 m depth begins just in November.

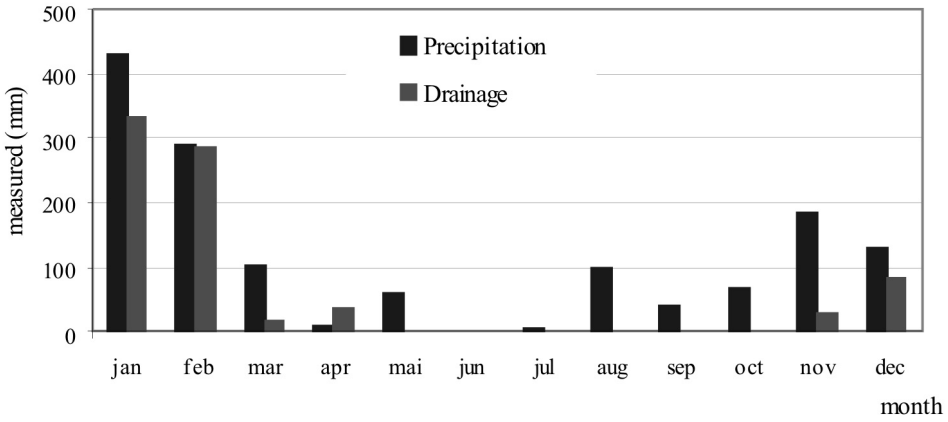

Figure 4: Measured precipitation and drainage in the lysimeter (January to December, 2002)

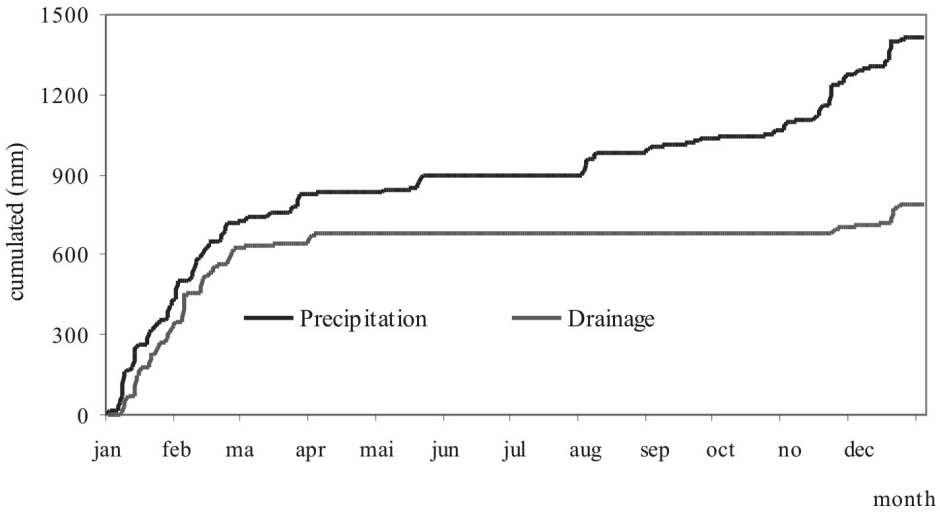

Figure 5: Cumulated precipitation and drainage from January to December, 2002

One of the water cycle components with greater uncertainty is the real evapotranspiration. Frequently, theoretical models developed for the North hemisphere are used for the estimation of the evapotranspiration, even when the local climatic conditions do not match the considered basic hypothesis, e.g. unrestricted moisture availability, leading to serious errors. In this sense, the data collected in the lysimeter were used for comparison with the evapotranspiration values estimated by the traditional methods of Thornthwaite (1948) and Penman (1956).

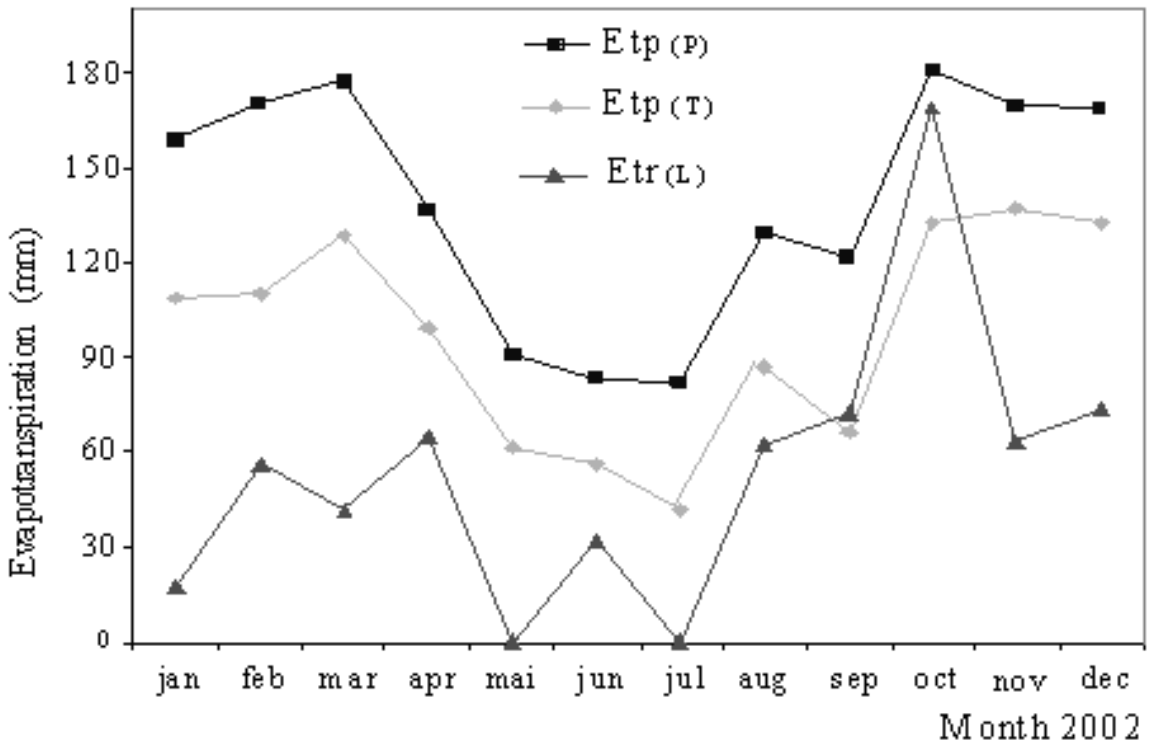

Figure 6: Monthly data for potential evapotranspiration estimated by Penman (Etp(P)) and Thornthwaite (Etp(T)) and real evapotranspiration (Etp(L)) observed in the lysimeter

Figure 6 shows the monthly data obtained for 2002. The estimations by the theoretical methods are greater than real evapotranspiration, both in humid and dry periods. The values estimated by the Thornthwaite method are closer to the experimental data mainly in the dry period, for which evapotranspiration is low due to restricted water availability and low air temperature. The total potential evapotranspiration estimated by Penman's method (1667.6 mm) for the observation period (January to December, 2002) exceeds the precipitated volume in the same period (1416.9 mm). The value corresponds to 260% of the real evapotranspiration measured in the lysimeter (651.04 mm). Thornthwaite's method estimates an evapotranspiration of 1169.51 mm, which still corresponds to 180% of the observed value.

Conclusion

Using a lysimeter filled with sandy coverage soil of the Botucatu outcrop zone, the drainage rate (potential groundwater recharge) was estimated to be 788.40 mm, which corresponds to 55.6% of the total precipitation of 1416.90 mm, observed in 2002.

Due to the characteristic high permeability (low water retention capability) of sandy soil, the infiltration of precipitation excess occurs rapidly. The coverage vegetation, characterized by grass with low root penetration (circa 30cm) extracts moisture only in the superficial layers. Upward moisture movement due to capillarity does not occur, since the pores in sandy soil are relatively large. This fact is evidenced by high moisture values observed in the deepest tensiometers, indicating the presence of a capillary barrier above the drainage system (Cunha, 2003).

The contribution to aquifer recharge occurs mainly between December and February, representing 90% of the total drainage in the year. During the dry period, the sparse precipitations are not sufficient to supply the moisture deficit up to 1.10 m depth. In this period the losses due to evapotranspiration are low, viewing the restricted moisture availability and low air temperature.

Aiming for the realization of a water balance, the theoretical methods for evapotranspiration estimation have to be used carefully, as already observed in the literature. In general, the methods by Penman and Thornthwaite are not suited for sandy soil and climate conditions characterized by hot-rainy summer and cold-dry winter, which normally occur in Brazil.

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Applied Geoinformatics for sustainable IWRM and climate change impact analysis.

Prof. Dr. Wolfgang Albert Flügel

1. Introduction

The IWRM process is driven by a system oriented, integrated and 'bottom-up' management approach and numerous literature has been published in this regard (Heathcote, 1998; Jain and Singh, 2003, GWP, 2009). Integration is promoted across sectors and groups in society, and is realized by identifying an agreed set of water management principles by means of applying a participatory approach bringing together representatives of key stakeholders, water managers and decision makers (Giupponi et al., 2004, 2008). This process, however, is not easy to implement because of contrary

(i) socio-economic water user demands from agriculture, rural and urban development, industries and the environment,
(ii) transboundary political interests and differing water related legislation and governance structures,
(iii) missing hydro-meteorological infrastructure and landscape information as the majority of river basins in this world are ungauged basins as defined by the IAHS-PUB initiative (Young and Romanowicz, 2004).

On a global scale especially semi-arid river basins that already have severe water stress at present show ongoing population growth, and widely suffer from land degradation, floods and droughts causing severe socio-economic damages, decreasing of livelihood, increasing poverty, and even loss of human lives (Wallace and Gregory, 2002). Because of their stressed environment they are highly vulnerable to impacts from climate change (Fischer et al., 2002; Querner, 2002). Scenario based simulations on a global scale (Alcamo and Henrichs, 2002) indicate that their scarce water resources will likely come under even more stress in the forthcoming decades (IPCC, 2007a, 2007b, 2007c; IUCN, 2003).

Both, the system oriented IWRM process and the lack of sufficient hydro-meteorological and landscape information require the integrated application of Geoinformatics. The latter generates synergy by deploying and developing IT components of geo-computation to access, analyse and model challenging problems related to sustainable and environmental sound land and water resources management. As a self-contained scientific discipline it develops innovative scientific concepts, applies and enhances methods and techniques of environment system assessment, analysis, and integrated modelling and thereby provides needed information and know-how for decision support. Applying a holistic systems approach (Flügel, 2000) and accounting for scale related system process dynamics Geoinformatics toolsets like JESAT have been developed (Flügel, et al., 2009). The system integrates software components of remote sensing, Geogra-

phic Information Systems (GIS), global positioning systems (GPS), landscape assessment and terrain analysis, process studies from field campaigns, distributed modelling of environment system dynamics, object related information knowledge systems, and networking technologies.

Climate change (CC) is a consistent global challenge (Alcamo and Henrichs, 2002; IPCC 2007a, 2007b, 2007c) and throughout the world there is a rising concern that global warming will influence a wide spectrum of drivers that are likely to impact and alter our continental and global hydrological domains in terms of natural and socio-economic processes (IPCC, 2000; IUCN, 2000). In response to this challenge the Intergovernmental Panel on Climate Change (IPCC) has been established by WMO and UNEP to assess scientific, technical and socio- economic information relevant for the understanding of the potential impacts and vulnerabilities, and to develop conceptual options for mitigation and technological as well as socio-economic adaptation.

Since the reduction of greenhouse gas emissions has proved difficult, (Querner, 2002; IUCN, 2003) it is becoming ever more evident that mitigation of the impact from this component will not be sufficient to protect societies from the effects of climate change. Adaptation strategies have to be developed and Integrated Water Resources Management (IWRM) as defined by the GWP-TAC (2000) has been identified internationally as the appropriate strategy to cope with likely impacts on people, businesses, societies, economies and environment at large (Smith et al., 1996; IUCN, 2003; GWP-TEC, 2004).

2. IWRM and Geoinformatics

2.1 Participatory IWRM process

The IWRM process requires coordinated decision-making about land and water resources management and requires a holistic system approach that accounts for scale related cross-sectoral issues together with participatory and adaptive strategies towards sustainable management of land and water resources. The key action is collaboration between stakeholders when dealing with competing and sometimes conflicting water demands for the limited river basin water resources. This must be complemented by interdisciplinary research integrating scientific disciplines from natural sciences, engineering and socio-economics and accounting for governance regulations implemented in different political domains.

Involving key stakeholders in a participatory approach strives to define commonly agreed decision principles to achieve sustainable water resources management in terms of quantity and quality and requires proper communication interfaces (Horlitz, 2006). The NetSyMod approach presented by Giupponi et al. (2006, 2008) is an example of such an system and has been tested

successfully in EU projects. It applies the Delphi Method (Giupponi et al. 2006; Nevo and Yolande, 2007) that evaluates knowledge based consensus from a group of experts using repeated responses of questionnaires and controlled feedback related to issues of IWRM decision making.

2.2 Framework of climate change

Present global climate modelling state-of-the-art is presented in the 4th Assessment Reports of the IPCC (IPCC, 2007a, 2007b, 2007c) that are compiling the results from 21 different atmosphere-ocean global circulation models (AOGCM) for the IPCC scenario A1B (IPCC, 2000). They have been evaluated as multi-model datasets (MMD-A1B) in the Program for Climate Model Diagnosis and Intercomparison (PCMDI). According to the 4th IPCC report the temperature projections based on the MMD-A1B models represent a strong warming over the 21st century. Warming greater than the global mean is projected for South Asia (3.3°C) and East Asia (3.3°C), and significantly higher than the global mean in the continental interior of Asia (3.7°C in central Asia, 3.8°C in Tibet and 4.3°C in northern Asia).

The challenge of downscaling of the global macro-scale resolution to a regional basin scale must be met to refer the GCM results to a scale that is relevant for IWRM. This is done by means of Regional Climate Models (RCM) based on climate processes (Ahrens, 2003; Klein et al., 2005; Kumar et al., 2006) and by means of geo-statistics using climate and land surface parameters (Lapin et al., 2001; Schmidli, 2006; Wilby et al., 2004) complemented by deploying satellite based techniques. The downscaling procedures generate tera bytes of modelled hydrometeorological data time series that require sophisticated software tools to extract the spatial information required for multi-scale river basin system analysis.

2.3 Adapting to climate change

Adapting IWRM strategies to climate change is based on a set of emission scenarios (IPCC, 2000) which are treated as driving forces in the Driver Pressures State Impact Response (DPSIR) approach proposed by the European Environmental Agency (EEA, 1999). This approach to a large extent requires geo-spatial information obtained from Geoinformatics comprising a comprehensive system assessment and scenario based modelling analysis. Results are input to Decision Support Systems (DSS) like the MULINO-DSS (Giupponi et al. 2004; Giupponi, 2007) that integrates expert knowledge and stakeholder views obtained from Delphi exercises. The DPSIR approach (EEA, 2005, 2008b) has been applied for the analysis of adaptation strategies to climate change in Europe and its methodical concept offers great potential for application internationally. The decision making process to a large extent is based on indicators that in some way express the status of the natural, socio-economic and governance domains, and therefore must be readily available to decision makers by means of user friendly Decision Information Support Tools (DIST).

2.4 Application of Geoinformatics

Within the framework spanned by the ongoing adaptation of our environment to changing LULC, partly triggered by climate change on the one side and its gradual impacts on IWRM on the other side Geoinformatics as a synergetic discipline provides concepts, methods and tools to carry out the assessment and analysis of these impacts on sustainable land and water resources management. This is shown schematically in Figure 1 and can be described as follows:

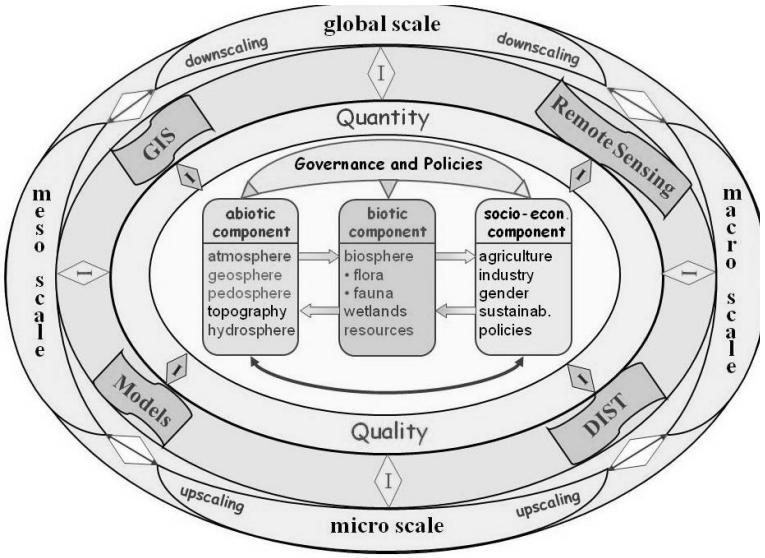


Fig. 1: Integration of Geoinformatics tools for multi-scale IWRM

(i) River basin systems comprise three different core components, the abiotic and biotic resources and the socio-economic services they provide. They are interactively linked with each other by means of process based feedback interactions.

(ii) All of them are either directly or indirectly influenced by governance regulations and politics, i.e. by the Water Framework Directive (EU-WFD) of the European Community (EC) that strives to implement sustainable land and water resources management.

(iii) The interactive system process dynamics between the three core components and their management by governance structures impacts land and water resources both in terms of quantity and quality.

(iv) For the spatial system assessment of the core components Geoinformatics developed remote sensing techniques, GIS, process models and web based Decision Information Support Tools (DIST) for component interaction analysis and management decision support. By means of respective methodical interfaces they relate the quantity and quality issues of the river basin to the three core system components accounting for the scale of interest.

(v) From the scale specific integrated system assessment and analysis enhanced knowledge and insight is obtained, which by means of conceptual interfaces can by upscaled to higher or downscaled to lower scales, hence generating the synergy required to understand integrated process system dynamics.

Ready to use toolsets like JESAT (Flügel et al., 2009) or ILMS (Fink, et al., 2007b) have been developed to elaborate on the following research challenges that address the following issues of sustainable IWRM and adaptation to climate change:

(i) Application of a holistic approach for multi-scale system assessment and modelling analysis of river basins and their nested tributary network.

(ii) Development of a process oriented conceptual landscape model that synergetically classifies the different landscape components according to their effects on the process dynamics under research. This landscape model generates distributed Response Units (RU) as class entities that have a unique process dynamics when transferring RU input into a corresponding output.

(iii) GIS tools to delineate RU accounting for multi-scale resolution of the different landscape components, and to generate a topological RU network for the gradient driven flow and transport between RU into the receiving river stretch.

(iv) Development of a model framework system (MFS) that provides a modular structured model development platform for researchers and a user friendly model runtime environment for practitioners.

(v) Development of physically based models applying RU as distributed model entities to model dynamic system processes, i.e. water, solute and erosion transport as a means for scenario based impact analysis of climate change on IWRM.

(vi) Design of web based data and information systems to preserve and disseminate the knowledge obtained from the system assessment and process analysis and providing a user friendly way for decision support.

3. Literature Review

A brief review of the numerous literatures published in relation to IWRM and climate change has been given in the previous chapters and hence the following discussion will focus on the state of the art regarding the scientific potential offered by Geoinformatics to address the system challenges identified. Concepts, methods and software tools that comprise the Jena Environment System Analysis Toolset (JESAT) will be presented and discussed in brief.

3.1 Holistic approach in multi-scale system assessment and modelling

With respect to river basins, a holistic system approach can be described as the process of assessing and analysing the complex multi-process driven systems dynamics at the scale of interest and relating the obtained insight to higher and lower system scales hence gaining understanding of the system's integrated functionality. The challenge of such a complex approach is inherent in two facts: **(1)** the interaction between natural processes and their scale related functional priorities is often not understood, and **(2)** socio-economic and governance activities add the human dimension to this natural complexity, making the system even more difficult to manage and to predict the impacts of external drivers, like climate change. Figure 2 classifies hydrological catchment studies with respect to their relationship to spatial landscape heterogeneity, time of system impact response, and understanding of scale related process interaction, and reveals:

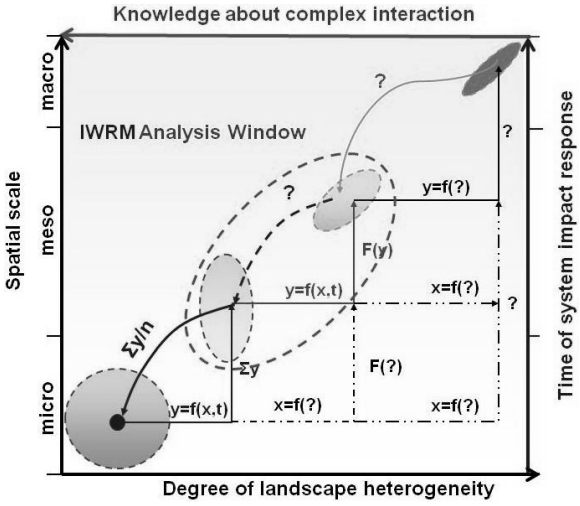


Fig. 2: Relationship between river system scale, spatial heterogeneity, response time and process knowledge with respect to upscaling and downscaling

(i) Spatial landscape heterogeneity and the response time of the system to external impulses are both increasing with scale. Increasing spatial heterogeneity of the systems' component structure makes it more difficult to understand the complex process interaction between scales within the system and therefore the knowledge about such dynamics is decreasing with increasing system scale.

(ii) The distribution of catchment studies is left-skewed with the majority of studies focussing on the micro-scale, less with focus on the meso-scale, and few studies deal with macro-scale river basins like the Mekong, Mississippi or the Nile.

(iii) Micro- and meso-scale river systems have a low or medium degree of spatial landscape heterogeneity and short response times to external system impacts. Hence that can be analysed by means of measured historical time series. Macro-scale river systems are characterized by a high degree of landscape heterogeneity and have response times that are longer then reliable hydro-meteorological data time series date back in the past.

(iv) Consequently the know-how about the complex interactive process dynamics between scales is quite well developed in the lower scale range, i.e. between the micro- and the lower meso-scale but lacks understanding between the higher meso- and the macro-scale ('?' in Figure 2).

(v) The process of upscaling and downscaling is affected by the inverse relationship between scale and knowledge of process interaction because the transfer algorithms between scales are frequently unknown (indicated by '?' in Figure 2).

(vi) IWRM typically is implemented on the meso-scale and often in a transboundary domain. At present it is possible to transfer algorithm and knowledge obtained from micro-scale catchment studies to the lower meso-scale and vice versa. However, downscaling of global macro-scale climate change dynamics to IWRM implementations on the meso-scale is still a research challenge to be met.

From this discussion the present constraints of climate change impact analysis for IWRM adaptation becomes obvious: Results from global climate models (GCM) and regional climate models refer to the macro-scale or the higher meso-scale (Ahrens, 2003) and provide input to global water models (Alcamo and Henrichs, 2002). Because the issue of downscaling from macro-scale to lower scales is still unresolved (Klein et al., 2005; Kumar et al., 2006) they are of only limited value for the majority of IWRM applications, which happen to be at the meso-scale.

3.2 *Conceptual landscape model of Response Units (RU)*

The scale related framework from Figure 2 is also of relevance for the differentiation of process related landscape units within a basin, that transfer basin input, i.e. rainfall in corresponding basin output, i.e. evapotranspiration and river runoff. This process is called regionalization and elaborates on methods to delineate model entities within the landscape of the river basin. A comprehensive overview of the different approaches developed in hydrology is published by Kalma and Sivapalan (1995). Today two different concepts are applied in basin models which in different way account for the process dynamics in the river basin:

(i) Grid cells differentiate the basin into units of equal size which are not process based.

(ii) Response Units (RU) are process based polygons of different size, which are delineated based on the insight gained from a thorough basin hydrological system analysis.

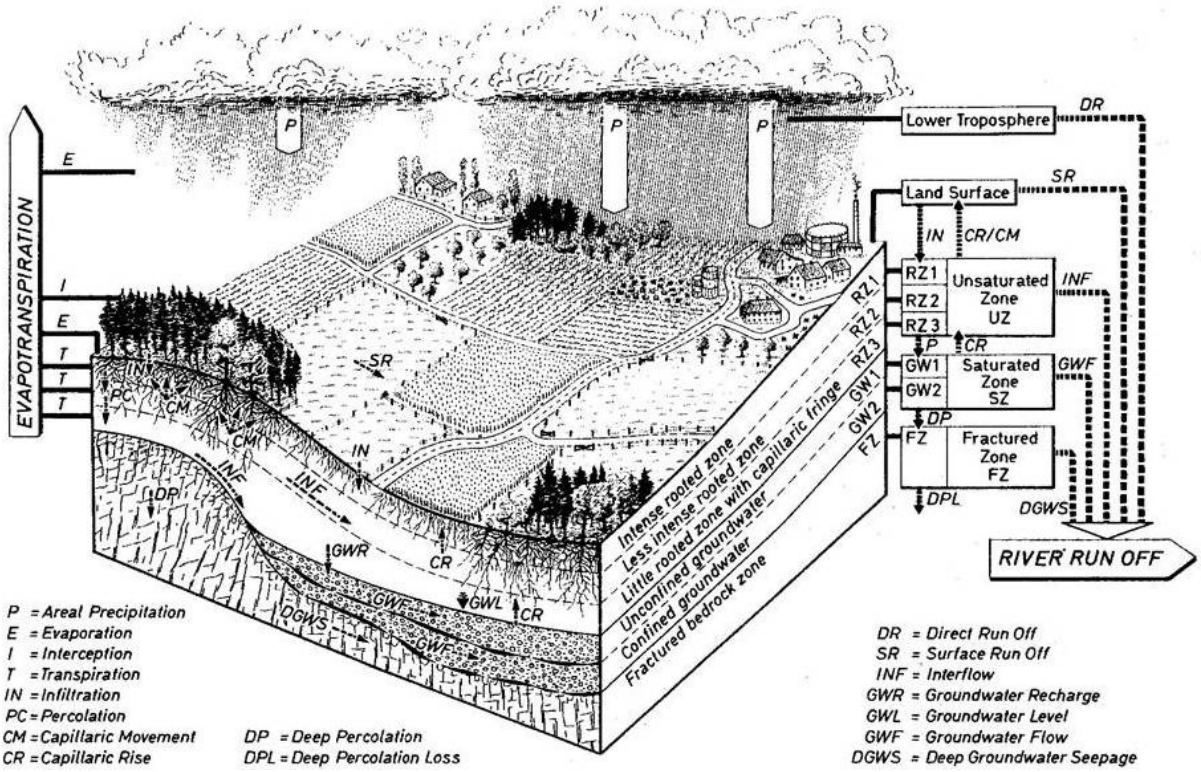
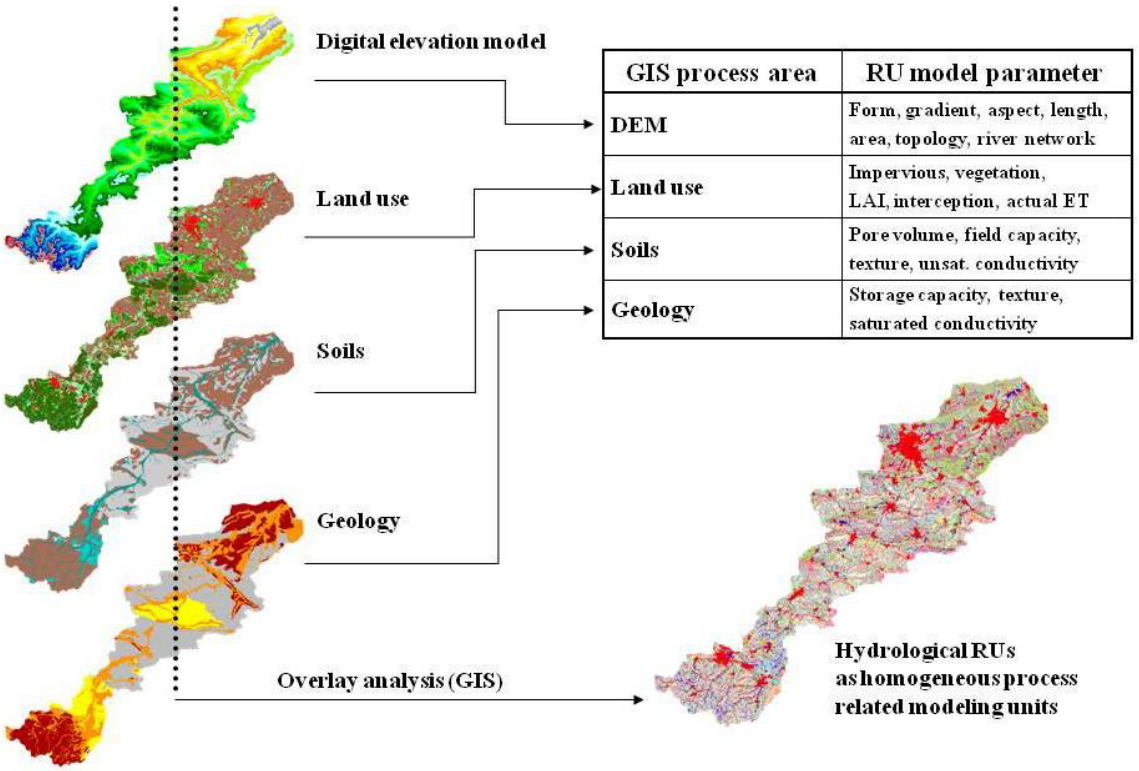


Fig. 3: Schematic presentation of the interactive hydrological process dynamics active in and between landscape components when transferring precipitation input into evapotranspiration and river runoff as corresponding system output components.

The conceptual RU landscape model has been introduced by Flügel (1995; 1996) and because of its process relevance is able to cope with the IWRM challenges identified from Figure 2. As shown in Figure 3 the RU landscape model is based on the fact that the hydrological process dynamics of water and solute transport within a river basin is controlled by the vertical assembly of site specific landscape components like topography, soils, land use and land cover (LULC),

and geology. They together constitute classes of specific process dynamics and contain spatial distributed class entities, named Response Units (RU). Hence each class with its RU entities represents a specific structure of interactive processes comprising storage, transfer and output, which is unique of this kind within the RU of each class. By means of the conceptual RU landscape model each process dynamics that is relevant for IWRM can be represented by respective distributed model entities, i.e. Erosion Response Units (ERU) (Flügel and Märker, 2003), Hydrological Response Unit (HRU) (Flügel, 1996; Krause, 2002) and Chemical Hydrological Response Units (CHRU) (Bende et al., 1995; Fink et al., 2007a, 2007b).



GIS process area	RU model parameter
DEM	Form, gradient, aspect, length, area, topology, river network
Land use	Impervious, vegetation, LAI, interception, actual ET
Soils	Pore volume, field capacity, texture, unsat. conductivity
Geology	Storage capacity, texture, saturated conductivity

Fig. 4: Schematic presentation of HRU delineation by means of GIS overlay analysis using digital data layers.

3.3 RU delineation and topology

The delineation of RU is done by means of GIS analysis as schematically shown for the delineation of HRU in Figure 4 and is using digital data layers and spatial information obtained from remote sensing analysis. The latter either can be done by means of selected satellite images or by applying readily available LULC classification from the public domain (PD), i.e. from the GOFC-GOLD initiative of the European Space Agency (ESA). The GIS procedures necessary to carry out the RU delineation have been described in detail (Flügel, 1995, 1996; Krause, 2002; Krause et al., 2006) and are part of the JESAT (Flügel, et al., 2009).

The flow paths between RU to the receiving river network are an important issue for water,

sediment and solute transport. They are defined by means of a topologic model generated by one of the JESAT GIS tool components. The topologic flow model is calculated from a gradient analysis of the digital elevation model and delivers as a result the flow network between the RU towards the receiving river reaches. It also accounts for

(i) the breaking and correction of internal flow circles between RU,

(ii) one HRU can distribute its output to more than one neighbouring HRU,

(iii) RU adjacent to a river reach will deliver their output into the river (Pfennig et al., 2009).

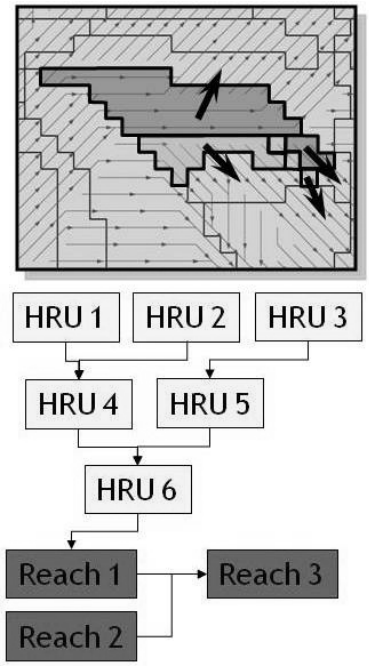


Fig. 5: Topologic model of gradient driven flow between RU to the receiving river

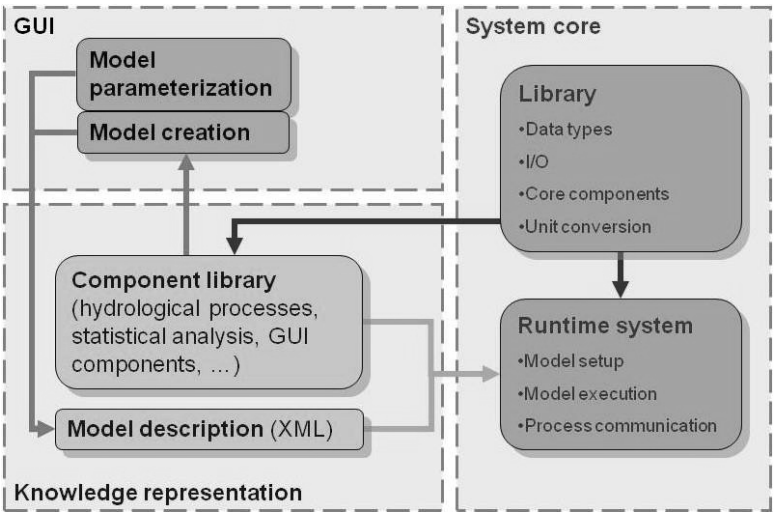


Fig. 6: Schematic design structure of the modular JAMS.

3.4 Modular Model Framework Systems (MFS) and JAMS

Modular model framework systems (MFS) provide an object oriented model development environment for the researcher and a user friendly runtime environment for the practitioner and IWRM decision maker. The motivation for developing MFS is based on the fact that monolithic software packages do not provide sufficient flexibility for component exchanges, but instead encapsulate their know-how within the code, making it unusable for other model development. A modular approach overcomes this methodical shortcut and permits to assemble different process modules into an adapted model hence accounting for individual data availability and process know how. In the past the following MFS have been developed:

(i) The Modular Modelling System (MMS) was one of the first MFS published (Leavesley et al., 1996) and has been successfully applied with the PRMS model by the United States Geological Survey (USGS), Denver, Colorado, USA.

(ii) The Object Modelling System (OMS) is a joint initiative of the United States Department of Agriculture (USDA), Fort Collins, Colorado, USA, and the Department of Geoinformatics, Hydrology and Modelling (DGHM), Friedrich-Schiller University (FSU-Jena), Jena, Germany (Kralisch, et al., 2005b) and continuously is enhanced for applications in the USDA.

(iii) Funded by the 5. Framework Programme of the European Commission (EC) the HarmonIT project with the OpenMI (Moore et al., 2004) has developed a generic procedure for model interfaces.

(iv) The CSIRO in Australia has released the Catchment Management Toolkit (CMT) which offers a wide range of modelling and management tools for IWRM.

(v) The DGHM in cooperation with the OMS and the MMS team has developed the Jena Adaptable Modelling System (JAMS) as a central JESAT component (Krause and Flügel, 2005; Kralisch and Krause, 2007; Kralisch et al., 2007).

JAMS contain the modules of the J2000 model suite and its component design structure is discussed in detail by Kralisch et al. (2005a). As shown in Figure 6 it comprises three types of libraries:

(i) *System core* libraries provide modules that describe and control the context of the model in terms of time steps and RU sequences. They also provide descriptions for data types, organize input/output handling, and the visualisation during runtime.

(ii) *Knowledge representation* is done by modules that contain algorithms to model processes depending on the time scale and the data input available. These modules are used to design the process body of the new model under development and the library will be enhanced from additional modules containing process algorithms.

(iii) *Graphical user interfaces (GUI)* for model generation and parameterization allow the model developer and practitioners to adapt the model according to different defined scenarios.

3.5 J2000 hydrological model suite

The concept of the RU landscape model is based on a thorough hydrological system analysis that provides the process related criteria for the RU delineation. These criteria, although related to the scale of the digital data layers used for the study, are consistent in their methodical concept so that they can be applied to higher and lower scales as well. At each scale RU are grouped in unique process classes which in their spatial distribution and specific arrangement represent facets of the spatial basin landscape heterogeneity. The latter controls the response delay of the river basin when transferring basin input via internal storages to the corresponding basin output.

The J2000 hydrological model suite has been developed to apply Hydrological Response Units (HRU) as model entities for modelling the water and solute transport dynamics within river basins. As a core modelling component of JESAT it comprises the following three models which each have a modular component structure as shown in Figure 7:

(i) The ***J2000*** hydrological model (Krause, 2002; Krause et al., 2006) comprises the atmospheric, soil and hydrological components of the right half of Figure 7. The model has intensively been tested in

international catchment studies to analyse and quantify the hydrological dynamics of micro- till meso-scale catchments for process based IWRM scenario analysis.

(ii) The ***J2000-S*** model was developed for process based water and solute transport modelling (Fink et al., 2007a). It is identical in its hydrological process structure with the J2000 model but in addition has model components shown in the left half of Figure 7. They describe agriculture management, plant growth, soil temperature and nitrate dynamics. The model has been applied successfully in river basins with intense agriculture that suffered from seepage of nutrients, i.e. Nitrogen from diffuse sources generating severe water quality problems due to river and reservoir eutrophication (Fink et al., 2007b).

(iii) The ***J2000-g*** conceptual model is a simplified version of the J2000 model. It is still process based but represents the basin hydrological dynamics in a much more conceptual way than it is done in the J2000 model. J2000-g has been developed for macro-scale scenario analysis and has been applied successfully for climate impact assessments for IWRM (Krause and Hanisch, 2009).

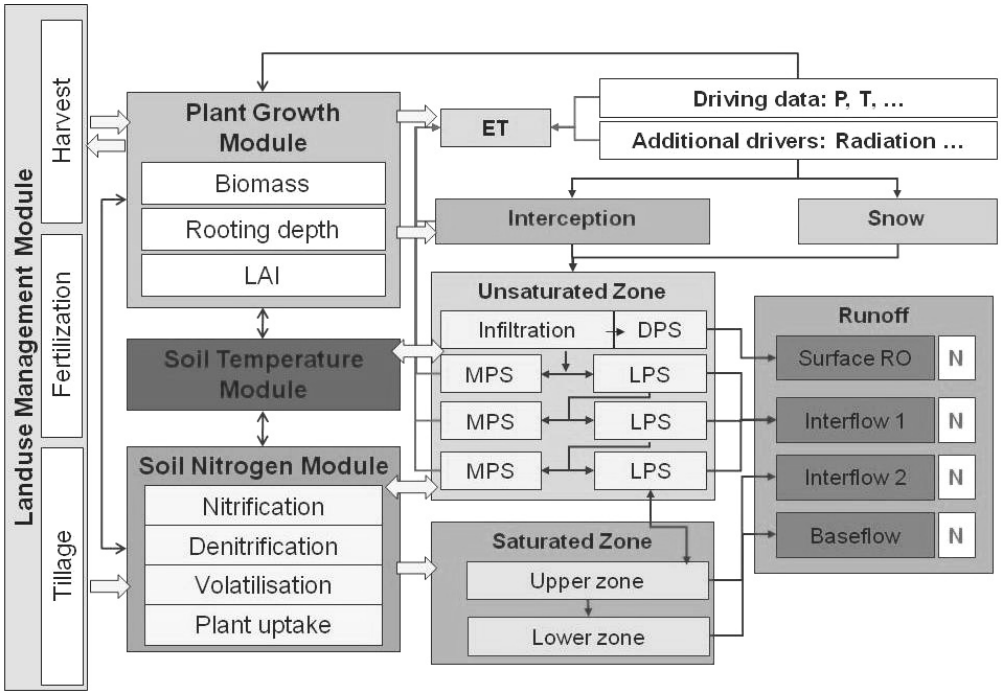


Fig. 7: Modular component structure of the J2000 (right half) and the J2000-S water and solute transport model of JESAT.

3.6 Adaptive Integrated Data and Information System (AIDIS)

As discussed above, IWRM should be based on the principles of integrated systems analysis (Flügel, 2000) elaborating on know-how and expertise that has been obtained and preserved from previous research. A Decision Information Support Tool (DIST) must manage various IWRM related data and information, i.e. station time series data related to water quantity and quality, socio-economic data, and digital maps that present the spatial distribution of such information and hence has to provide the following services and functionalities:

(i) User friendly graphical user interfaces (GUI) for populating the system based on the full implementation of the ISO 19115 standard and carrying out data and information queries.

(ii) Representation of the river basin's real world by differentiating between (a) generic components that are represented in all river basins, and (b) specific basin related components that reflect the regional conditions.

(iii) Import and export functionality and management of GIS digital data layers that have a geographic reference specified by a common coordinate system.

(iv) Integration of the different kinds of data and information for the design of "what-if-scenarios" applied for the evaluation of prognostic system management alternatives in the decision making process.

(v) Adaptivity of the system data model structure to allow for extensions depending on the progress of the system's understanding and knowledge achieved by researchers and decision makers.

AIDIS has been designed as the JESAT data and decision support component (Flügel, 2007) and is providing these services by using a hierarchical, multi-tier object class data model shown in Figure 8. The latter is generic in its design structure, and for each tier deploys XML based metadata GUI to represent relationships between classes. It therefore can be adapted to river basins of all type of landscape and climate by enhancing the multi-tier class layer structure by new class hierarchies or modifying existing ones.

A central role is given to the 'map-class' on tier 1, which is used not only for the visualization of results but also for spatial queries that refer to metadata and information from the 'MD Class' hierarchy and the 'Doc Class' hierarchy respectively. All data stored in AIDIS are described by means of the ISO 19115 metadata model, and enhancements of this model are realized by extended lookup tables (LUT). AIDIS employed the Minnesota Map Server (MMS) and makes use of the GIS functionalities provided by PostGIS. GIS maps can be imported and exported in all standard formats via the Web and thereby allows multi client GIS cooperation for dissemination, i.e. within a clearinghouse network (CN).

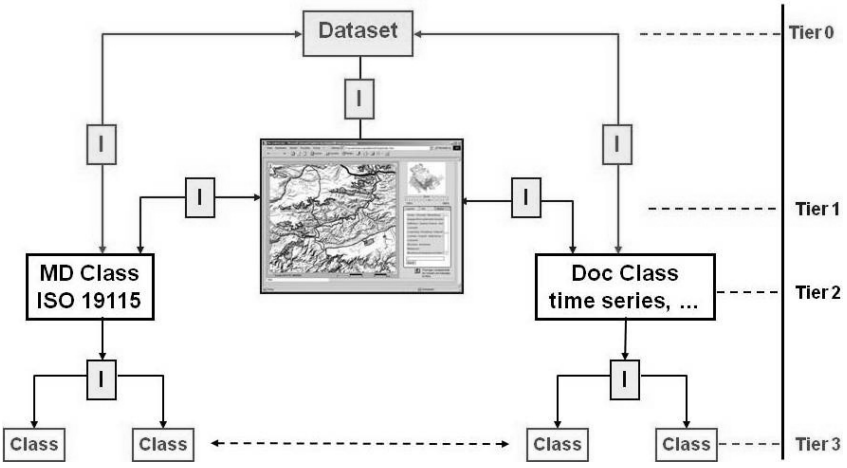


Fig. 8: Multi tier object relational data model of AIDIS

3.7 Jena Environment System Analysis Toolset (JESAT)

IWRM requires intensive and often transboundary cooperation between partners applying the same integrated toolsets to support the decision making processes. Addressing this need the JESAT components have been developed (Flügel et al., 2009). As shown in Figure 9 it integrates components for comprehensive assessment, analysis, modelling, and resources management support for environment systems applying a multi-scale, holistic system approach as described by Flügel (2000). As a multifunctional software toolset it comprises the software components described above which can be assembled by the practitioner into a basin specific Integrated Land Management Systems (ILMS) for IWRM and sustainable land resources management.

JESAT is based on the conceptual landscape model of distributed, process related Response Units (RU) applied as model entities in the J2000 model suite within the Jena Adaptable Modelling System (JAMS). It considers water quantity and water quality issues in an integrated way by applying remote sensing, GIS analysis, field process data and system modelling techniques in a consistent and scale related way thereby accounting for multi-scale application. JESAT users are furthermore offered innovative techniques from remote sensing and GIS incorporated into AIDIS enhancing the latter towards an environment knowledge base for system management and decision support. A literature review done by the European Environmental Agency (EEA, 2008) reveals that the development of integrated toolsets like JESAT or OIKOS (Olazabal et al., 2007) at present are cutting edge research.

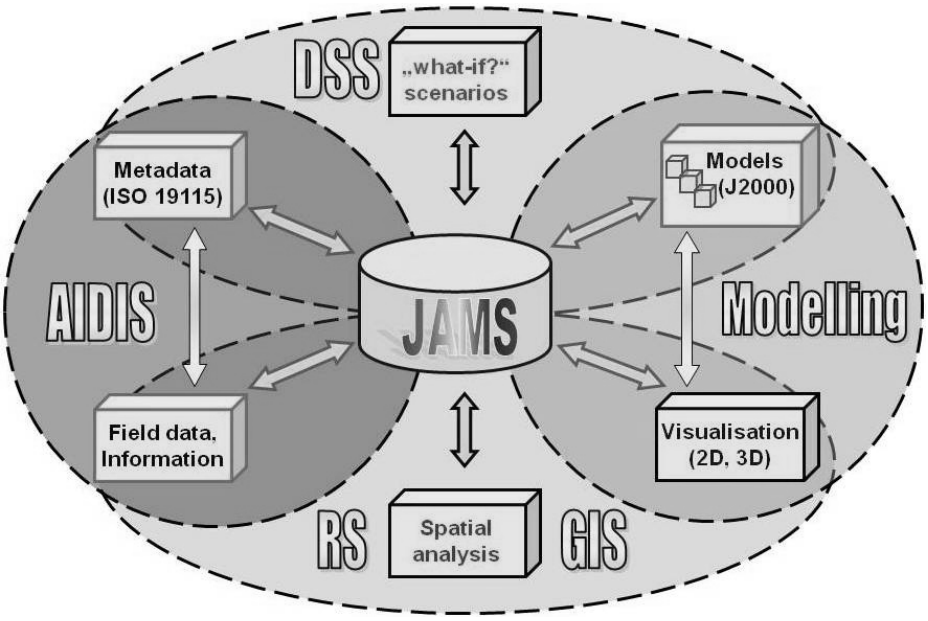


Fig. 9: Multi component JESAT structure to develop basin specific ILMS for sustainable IWRM

4. Study basins, Objectives, Methods, Tools and Results

Geoinformatics by means of JESAT has been applied successfully in various collaborative projects concerning IWRM, environment system research, and climate change impact analysis in Europe, Africa and Asia. Three of them will be presented in this paper. They assessed and analysed the impacts of changing land use and land management on the water and solute transport, both important ecosystem processes within a river system. As LULC changes and consequent adaptations of land and water resources management are most likely impacts from climate change the results obtained from these JESAT applications provided valuable expertise for scenario based climate change analysis.

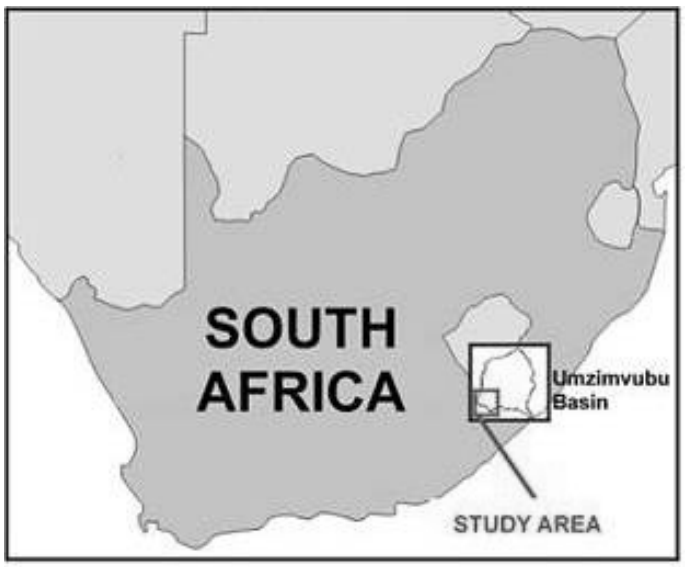


Fig. 10: Location of the study area in the Eastern Cape Province of South Africa

4.1 Mooi River basin, Eastern Cape Province, South Africa

The location of the Mooi River (A = 307 km^2) a second order tributary of the Umzimvubu River (A = 19.852 km^2) in the Eastern Cape Province of South Africa is shown in Fig. 10. The catchment has a unique landscape structured by sandstone escarpments and valleys formed in strata of mud stones and silt stones. Different types of wetlands have developed in this impressive landscape as unique environment features (Helmschrot and Flügel, 2002).

Since 1990 the land use of the headwater region of the Mooi River has been significantly changed as about 60,000 ha of former range land have been afforested with pines and eucalypt industrial forests (Figure 11). It was expected that the significant change of land use will impact the hydrological dynamics of the Mooi River system and the functioning of wetlands as unique environmental features of the former cultural landscape in particular (Helmschrot, 2006a, 2006b). In cooperation with colleagues from the University of Kwazulu-Natal, South Africa a cooperative 8-year research project was implemented with the following objectives:

(1) Hydrological system analysis to identify the process dynamics of wetlands.

(2) Differentiation of wetland types according to landscape component assembly, vegetation types and hydrological dynamics.

(3) Modelling of present discharge generation from the classified wetlands and under the two scenarios of (i) unchanged grassland LULC and (ii) afforestation to the full landscape potential.

Fig. 11: Large scale afforestation of former range land

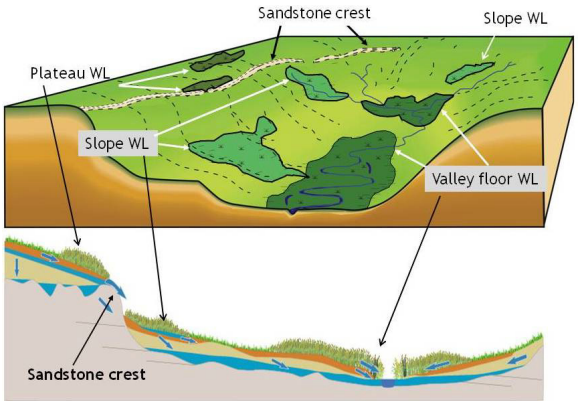


Fig. 12: Landscape oriented distribution of wetlands.

JESAT was applied in a stepwise approach and produced the following results (Helmschrot, 2006a, 2006b):

(i) A comprehensive system assessment was done by means of intensive field campaigns and landscape system analysis. They focussed on the representative micro-scale test catchment of the Weatherly Creek and were validated in the Mooi River catchment. In result the following three different types of wetlands (WL) shown in Figure 12 with each specific hydrological dynamics and adapted vegetation were defined (Dahlke et al., 2003, 2005):

- *Plateau WL* behind the rim of sandstone plateaus fed by seasonal rainfall and seeping out of the sandy groundwater aquifer developed in the weathered zone of the plateaus.
- *Slope WL* fed by rainfall and interflow also with seasonal dynamics following the rainfall pattern and the inflow from the upslope laying plateau WL.
- *Valley floor WL* fed dominantly by rainfall and groundwater seepage with perennial or periodic water courses meandering in the flat and broad valley floors.

(ii) Hydrological Response Units (HRU) were delineated by means of GIS analysis using digital data layers of a terrain model, LULC classification obtained from Landsat_TM satellite image classification, soils from the South Africa soil survey and geology from a respective geological survey.

(iii) The HRU model entities were parameterized and the hydrological dynamics of the Weatherly Creek between 1999 and 2001 and the Mooi River between 1980 and 2003 were modelled using the J2000 model. The model exercises were done for the two scenarios of unchanged LULC and assuming afforestation to the full potential of the landscape.

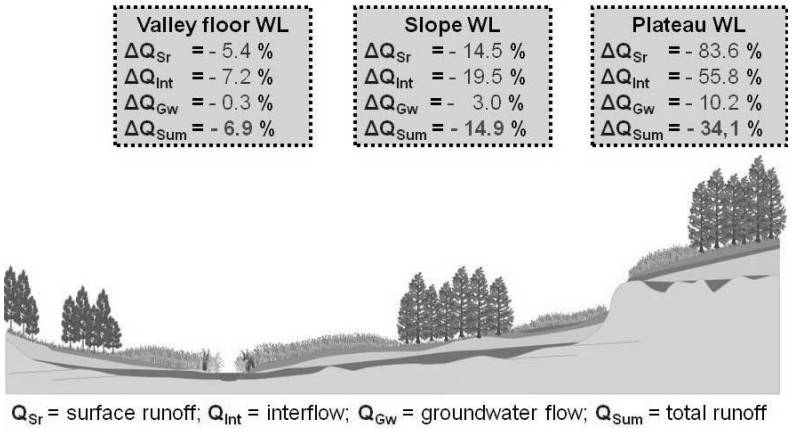


Fig. 13: Modelled change of runoff components from different wetland types due to afforestation.

The results obtained (Helmschrot, 2006a, 2006b) are shown in Figure 13 and reveal that the three wetland types and their runoff contributing components will be affected in different ways and magnitude from the afforestation activities:

- The small and only seasonal active *plateau WL* will be reduced in their runoff contribution by about 34 % in total as the forest on the sandstone plateaus increases evapotranspiration due to higher interception and water consumption, and their surface runoff contribution will almost cease.
- *Slope WL* will lose in average about 15 % of their discharge contribution as less groundwater will seep over the sandstone crest into the slope soil and hence less interflow and surface runoff will be generated.
- *Valley floor WL* will experience the least loss of only 7 % discharge contribution as they mainly get recharged by rainfall on their broad valley floors and hence are less depending on inflow from the slopes and plateaus.

4.2 Weida River Basin, Thuringia, Germany

*Fig. 14: Location of the Weida R*iver basin in Thuringia, Germany (modified from Kralisch et al., 2005b).

The Weida River in East Thuringia is draining an area of about 102 km^2 in the eastern part of Thuringia which is a federal state of Germany (Fig. 14). The basin has been described in detail by Fink (2004). Its altitude varies between 355 and 565 m above sea level, the annual average precipitation is about 640 mm, and the respective temperature about 7 °C. Two thirds of the catchment is used for intensive agriculture and soil fertility is based on continuous N-supply with manure and chemical fertilizers. The Weida River flows into the Weida-Zeulenroda reservoirs which supplies potable water to a population of more than 100.000 people in East Thuringia. The reservoirs are impacted by high input loads of Nitrate from the Weida River, which receives this load by subsurface seepage, interflow, and groundwater flow from the adjacent agricultural lands (Fink et al., 2007b). This N-input during the summer season is causing eutrophication and consequent algae blooms which resulted in high water purification costs to eliminate the chlorophyll content. In cooperation with the reservoir administration an IWRM research project was implemented with the following objectives:

(1) Identification and quantification of the distributed areas of nitrate N-input and modelled N-output as a base for the design of sustainable land management options.

(2) Development of recommendations to optimize N-reducing measures like annual payments to farmers that were compensating for harvest losses when using less N-fertilizers.

(3) Development of land management scenarios based on tolerable N-input threshold values to optimize farmer's compensation payments.

JESAT was applied in this project as follows:

(i) HRU were delineated by means of digital GIS data layers of terrain, soils, LULC, and geology and their topology was generated based on the digital elevation model (DEM) available to describe the transport of water and solutes within the HRU network towards the receiving Weida River.

(ii) Hydro-meteorological station data and fertilizer input on a field scale were collected from the German Weather Service (DWD) and cooperating farmers respectively.

(iii) The J2000-S water and solute transport model from JESAT was applied to model the distributed N-input and N-output dynamics of the HRU within the catchment and to transport the flow and N-output between HRU to the receiving Weida River.

(iv) To elaborate the efficiencies of nitrate reduction measures, i.e. compensation payments to farmers a multidimensional sensitivity analysis was carried out by applying the HydroNet neural network tool of JAMS (Kralisch et al., 2005) to the topology of the HRU network.

The results of the J2000-S modelling for the Weida River catchment and the two reservoirs are shown in Figure 15 and reveals:

(1) There is a significant differentiation of N-output according to land use, i.e. forestry versus agriculture, and crop management in terms of crop rotation and fertilizer application.

Forested HRU have a very low input to the Weida River of less than 5 kg/ha*a.

(2) Grassland, i.e. pastures and meadows have the second lowest N-output between 5 and 20 kg/ha*a.

(3) Agriculture fields supply the bulk of the N-input into the Weida River ranging between 20 and 200 kg/ha*a depending on the crop rotation and fertilizer management. Some 'hot spots' even exceed the annual output of 200 kg/ha N-output if shallow soils receive high fertilization rates.

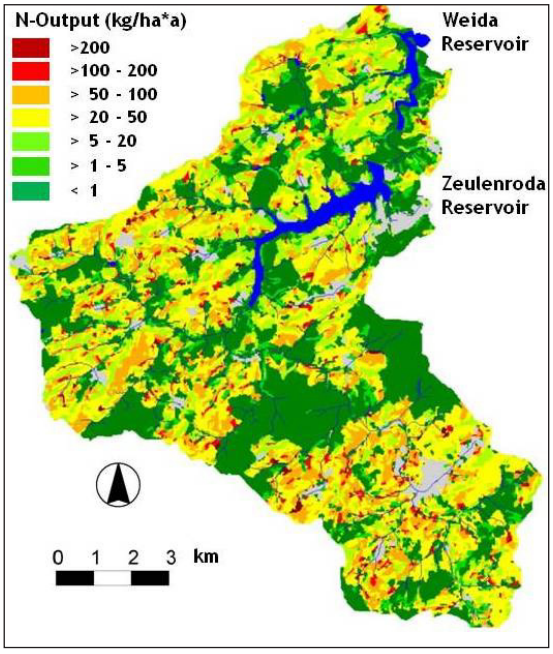


Fig. 15: Modelled distributed N-output from a HRU network within the Weida River catchment.

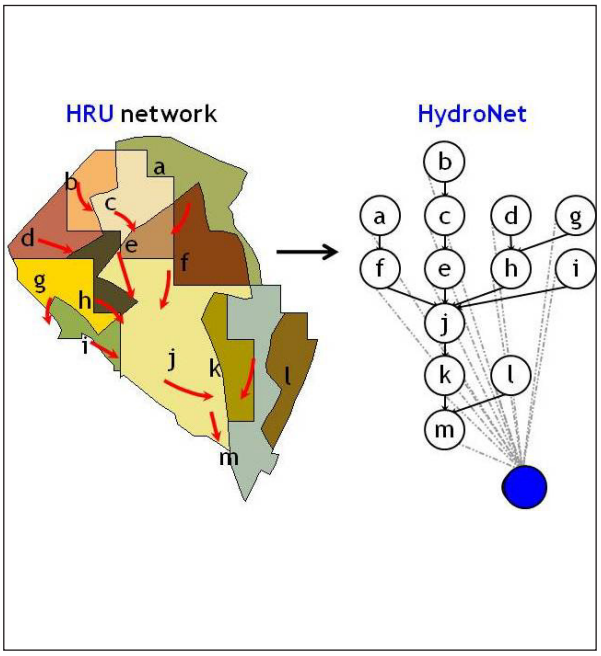


Fig. 16: *Transfer of the HRU topology into a HydroNet (from Kralisch et al., 2005b).*

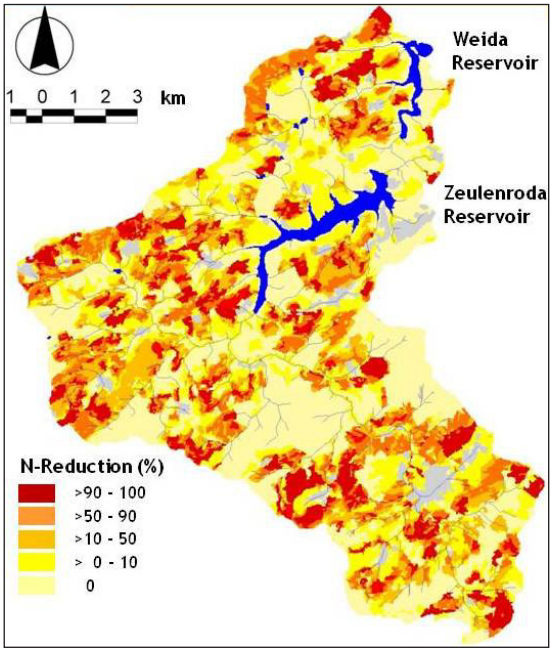


Fig. 17: N-reduction efficiencies derived from compensation payments.

In a next step threshold values for N-inputs that could be compensated for by the biological demineralization potential within the reservoir were identified and referred to the HRU network. This was done by means of the HydroNet component of JAMS (Kralisch, 2004; Kralisch et al., 2003). As shown in Fig. 16 the latter is generated by transferring the topologic HRU model into an Adapted Neural Network (ANN). Their linking edges were defined by the vertical and lateral HRU flow paths weighting provided by the J2000-S model. Each HRU-neuron is associated with a polynomial activation function describing the N-output of the respective HRU from scenario based N-fertilization runs of the J2000-S model (Kralisch et al., 2005b). By means of a backpropagation algorithm the N-load threshold value for the reservoir was then referred to the HydroNet. The results are shown in Figure 17 as the distribution of HRU related efficiencies of farmer compensation payments to achieve the N-load threshold value. They can be interpreted as follows:

(1) Different to the N-output distribution of Figure 15 the highest efficiencies of compensation payments with respect to the reduction of N-input into the reservoir are distributed over all types of crop rotation.

(2) Higher N-reduction efficiencies are not only limited to the protection zone 2 defined by German law as a buffer around the reservoirs but are scattered all over the basin.

(3) High N-reduction efficiencies could be achieved in shallow soils with higher permeability and higher fertilizer input.

The HydroNet N-reduction efficiency assessment provided new and valuable information to the reservoir administration about the use of limited financial resources to optimize the efficiency of this measure and was successfully applied since then.

4.3 Climate change impact assessment for IWRM in Thuringia, Germany

Climate change scenario analysis is also of high relevance in the Free State of Thuringia and IWRM impact assessments have proved their importance for sustainable water resources management (Krause and Hanisch, 2009). Thuringia covers an area of 16.172 km^2 and is located in the middle of Germany (Fig. 14). Its landscape can be differentiated roughly into three major components:

(1) *Thuringian Forest* a middle mountain ridge stretching from the SW to the SE of the state mainly covered by coniferous forest.

(2) *Foreland Zone* built up from sandstones and lime stones, partly forested and used for agriculture and stock breeding.

(3) *Thuringian Lowland* with intense agriculture on very fertile degraded Tschernosem soils.

The annual rainfall pattern in Thuringia is characterized by a distinct windward-lee effect. The westerly winds are bringing moist air from the Atlantic Ocean and when crossing the Thuringian Forest ridge they are forced upward and lose their moisture by precipitation.

When flowing further to the NE they bring less and less rain to the foreland zone and the Thuringian lowland laying in lee of the mountain ridge. As a result of this spatial rainfall distribution most of the rivers in Thuringia are having their headwaters in the Thuringian mountain ridge. Figure 18 for the past 30 years shows average winter season runoff peaking up to 450 mm in the Thuringian Forest: Towards the Thuringia lowlands this value is considerably reduced to values between 0 and 25 mm. This general distribution pattern also remains valid in summer, but here the mountain runoff generation decreases to 100 – 150 mm maximum.

To study likely impact of Climate Change on this runoff dynamics a research project was initiated by the Thuringian Agency for Environment and Geology (TLUG) which had the following objectives (Krause and Hanisch, 2009):

(1) Regionalisation of projected daily climate time series to available station locations.

(2) Delineation of HRU for Thuringia and modelling the hydrologic water balance by means of the J2000-g model.

(3) Identification of 'hot spots' where further investigations are required to implement sustainable water and land resources management according to the EU Water Framework Directive (EU-WFD).

JESAT was applied in this study as follows (Krause and Hanisch, 2009):

(i) HRU were delineated by means of GIS analysis using digital data layers of slope, LULC, aspect, soils, and hydrogeology.

(ii) They were applied as model entities in the JESAT model component J2000-g, a spatially distributed conceptual hydrological model.

(iii) Hydro-meteorological time series of measured station data and climate time series projections were provided by the TLUG. They have been referred to the existing climate station network to make the projection more comparable to the measured domain used to generate the results of the present situation in Figure 18.

(iv) The J2000-g hydrological model was successfully validated in altogether 12 test basins scattered in Thuringia and a parameter set for Thuringia was derived from this exercise.

The results of the modelling exercises were obtained for different SRES climate scenarios of which the mean monthly runoff generation 2071 – 2100 of the A1B scenario for the core winter and summer months is shown in Figure 19. In comparison with the present situation given in Figure 18 they provide the following information:

(1) Winter precipitation will concentrate on the SE part of the Thuringian forest, and as according to the A1B scenario temperature is increasing as well rainfall in winter will be more frequent.

(2) Winter rainfall on snow cover will increase the risk of flooding and IWRM decision makers will have to rethink the flood protection measures at present in place, i.e. the operation schedule of the flood protection reservoirs.

(3) In the Thuringian lowland the runoff generation is projected to reach zero values making this region winter dry and soil water deficits are likely to develop.

(4) During the summer months all regions of Thuringia will become significantly dryer if compared to the present situation, and runoff will be reduced respectively. However, the Thuringian lowland will experience distinct dry periods which will be a threat for agriculture in the summer months.

(5) Irrigation will become an important option for agriculture and water managers must develop appropriate strategies to guarantee a sustainable supply from reservoirs or groundwater resources to account for this additional water demand.

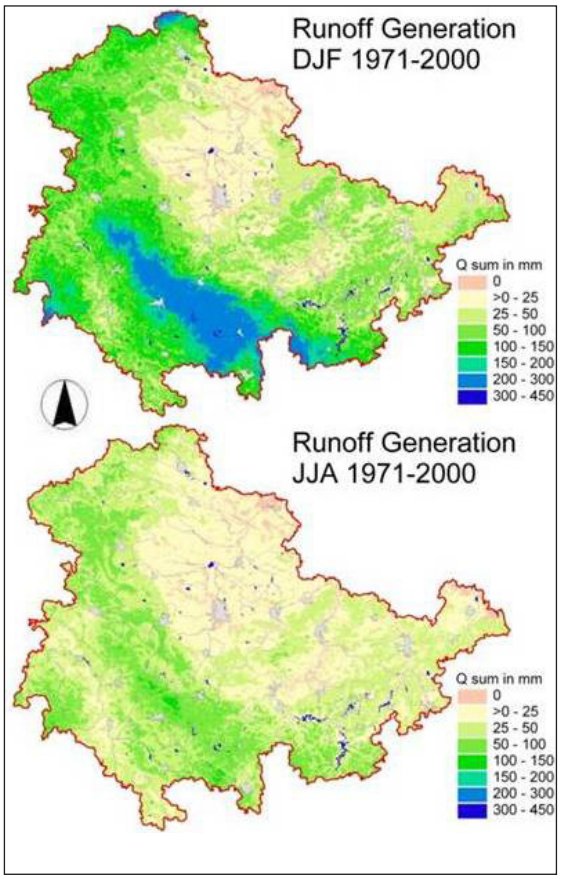


Fig. 18: Present mean DJF and JJA runoff generation in the Free State of Thuringia.

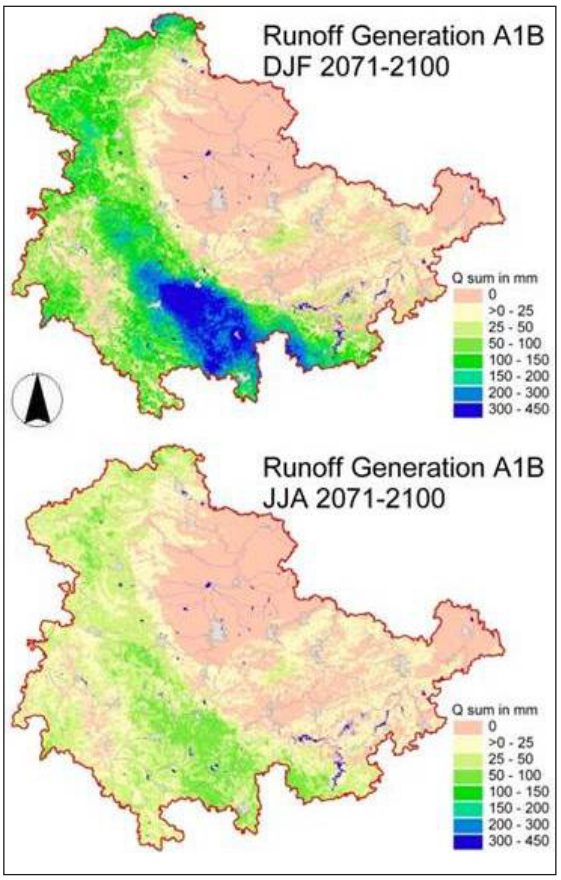


Fig. 19: Projected mean DJF and JJA runoff generation in the Free State of Thuringia.

5. Conclusions and Future Research

Geoinformatics is offering a wide range of concepts, methods and software tools, i.e. remote sensing, GIS, models and DIST that account for scale related issues of interactive process dynamics in river basins. Each of these tools used in a standalone application supports impact assessment of changing water and land resources management in IWRM due to changing climate. Their full potential for IWRM, however, can only be explored if they are integrated into a toolset that generates synergy by exploiting their interactive potential, and makes them available to researchers and practitioners for integrated, holistic system assessments and analyses.

The Jena Environment System Analysis Toolset (JESAT) is one of the most developed systems in this regard and has been applied successfully in many IWRM related interdisciplinary projects on almost all continents. It is based on the holistic regionalization concepts of Response Units (RU), which are process oriented modelling entities that represent the 'real world' of the river basin in a comprehensive way. JESAT comprises Geoinformatics tools that have been developed and tested in numerous projects since 1995 and are under continuous enhancement driven by ongoing application projects within the international IWRM domain. The tools of JESAT enable researchers and practitioners to assess and analyse their river basins and to design and apply individual Integrated Land Management Systems (ILMS) for sustainable IWRM accounting for likely impacts of climate change.

From the expertise gained and lessons learned so far future research regarding the application of Geoinformatics for environment system assessment, analysis, IWRM and sustainable land management should focus on the following issues:

(1) Scale related interactions of process dynamics must further be studied especially at meso-scale and macro-scale to better understand their respective process dynamics. In view of the holistic approach, the understanding of interactions between the micro-scale and the macro-scale should be the overall objective for upscaling and downscaling exercises.

(2) The conceptual and methodical integration of different tools, i.e. remote sensing, GIS, models and DIST must be improved as these techniques are commonly used in standalone applications without exploring their full synergic potential. By developing holistic landscape concepts Geoinformatics can provide the theoretical background for such interdisciplinary integration.

(3) Integrated toolsets like the JESAT component assembly provide the means for multi-scale assessment and process integration and should be furthermore supported in their development to make them readily available as a developing platform for researchers and a runtime environment for practitioners.

(4) National and international research funding programs should account to a higher degree to the requirements that are related to integrated, holistic systems research and the potential that can be offered from Geoinformatics to generate the required synergy for interdisciplinary cooperation.

6. Acknowledgement

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Fleischexporteur mit Modellcharakter - Bedeutung der uruguayischen Produktion von Rind- und Lammfleisch

Prof. Dr. Wolfgang Branscheid

Uruguay ist ein Agrarland, das trotz geringer Größe und trotz erheblicher Entfernung von den großen Lebensmittelmärkten in einer Reihe von Aspekten der landwirtschaftlichen Erzeugung weit oben in den von der FAO geführten Weltranglisten der Exporteure landwirtschaftlicher Produkte steht. Gerade die geringe Größe und der daraus resultierende hohe Grad der Spezialisierung machen es reizvoll, die Entwicklung des Landes im Hinblick auf die Rind- und Lammfleischproduktion und deren Umfeld aufzuarbeiten. Dabei sollen Aspekte der Produktqualität besonders berücksichtigt werden.

Weiden unsere Kühe am La Plata?

In der heutigen Situation des Weltmarktes sind wir, anders als vor 100 Jahren, weit davon entfernt, zwingend auf Fleischimporte aus den beiden La Plata-Ländern Argentinien und Uruguay angewiesen zu sein. Argentinien ist ohnedies, obwohl es die vier- bis fünffache Produktionskapazität des uruguayischen Volumens hat, in den vergangenen Jahrzehnten und bis heute immer wieder ein unsicherer Lieferant gewesen. Kurzatmige Regierungsmaßnahmen, sanitäre Probleme (Maul- und Klauenseuche - MKS), Trockenperioden und die starke Abhängigkeit vom Inlandverbrauch, die so in Uruguay nicht gegeben ist, waren die regelmäßigen Ursachen.

Andererseits erscheint Uruguay nur im Kontext der großen Nachbarländer unbedeutend. Betrachtet man beispielsweise die Flächenausstattung des Exportlandes im Vergleich zu Deutschland, so wird augenfällig, wie nahe beide Länder beieinander stehen. Zwar ist die Gesamtfläche Deutschlands doppelt so groß wie die Uruguays, die landwirtschaftliche Nutzfläche (LN) hat jedoch die gleiche Größenordnung (*Tab. 1*). In der Struktur der Kulturflächen zeigt sich aber die unterschiedliche Spezialisierung: Uruguay stützt seine Produktion zu mehr als 75 % auf Weidenutzung, die in Deutschland mit 15 % Anteil deutlich hinter dem Ackerland (34 %) zurücksteht. Zu beachten ist weiter, dass etwa 70 % der Gesamtfläche in Uruguay aus naturbelassenen Weideflächen („praderas naturales“) bestehen, die ausschließlich durch den Weideumtrieb gepflegt und ansonsten wenig beeinflusst werden.

Darin drückt sich der entscheidende ökologische Vorteil der uruguayischen Landwirtschaft aus, der von BACKHAUS und DIAZ (1907) weit vorausschauend hervorgehoben wird. Sie sehen die Nutzung durch extensive Weidehaltung als die einzig sinnvolle Produktionsform an. Dies hängt auch heute noch mit den entscheidenden komparativen Kostenvorteile der uruguayischen Produktion zusammen: Die Gewichtseinheit Rindfleisch kann zu einem Drittel bis einem Viertel der Kosten, die in den europäischen Ländern entstehen, produziert werden (DE-

BLITZ et al. 2004). GIUFFRA (1935) weist allerdings schon mahnend auf Veränderungen des ursprünglichen Charakters der Grassteppenlandschaft hin, die mit der Nutzung einhergehen. Dies wird im uruguayischen Umweltbericht durch neuere Erkenntnisse, z. B. zur Artenvielfalt ergänzt (ROU 1992). Für die zukünftige Entwicklung gilt, dass in Uruguay die Verhältnisse relativ stabil sind: Die landwirtschaftliche Nutzfläche und insbesondere die Weideflächen sind in den letzten 20 Jahren kaum zurückgegangen (- 0,8 % bzw. - 0,4 %; FAO), während in Deutschland 8 % der Fläche in andere Verwendung abgeschmolzen sind, die Weideflächen dabei weit überproportional (-16 %).

Den Charakter der uruguayischen Landschaft prägen die Rinder- und Schafherden. Daher steht Uruguay in der Größe der Tierbestände nicht hinter Deutschland zurück (*Tab. 2*). Der Bestand an Rindern liegt in Uruguay heute schon fast gleichauf, natürlich auch, weil er in Deutschland seit 1980 um 35 % gesunken ist und wohl auch weiter sinken wird. Bei den Schafen hat Uruguay den vierfachen Bestand, obwohl dieser seit 1980 um die Hälfte reduziert wurde.

Auch im Export der landwirtschaftlichen Produkte treffen sich Deutschland und Uruguay in manchmal überraschender Weise auf gleicher Augenhöhe. Dies gilt z. B. für: Honig (2004, Rang nach Wert, FAO: D-2., URU-8.), Sonnenblumenkerne (D-15., URU-9.), Gerstenmalz (D-5., URU-8.), Wolle (D-4., URU-10.), Tierhaare (D-4., URU-1.), Schafe lebend (D-17., URU-7.), aber eben auch für Rindfleisch (Teilstücke ohne Knochen; D-8., URU-9.) und Lammfleisch (D-10., URU-11.).

Die Präsenz auf den Exportmärkten über alle Produktkategorien betrachtet drückt sich in einem – aus uruguayischer Sicht – regen und wertmäßig bedeutenden Handel zwischen der EU und Uruguay aus: Die EU als größter Abnehmer nimmt 20 % der uruguayischen Exporte auf (Wert 2007 768 Mio. €; Eurostat) und liefert immerhin 14 % der Importe, die in Uruguay eintreffen (Wert 2007 741 Mio. €; Platz 3 nach Argentinien und Brasilien). 72 % der uruguayischen Exporte in die EU sind landwirtschaftliche Produkte, von diesen wiederum beziehen sich 80 % auf Rindfleisch. Für die EU machen diese aber nur 0,6 % ihrer Gesamtimporte aus.

Es weiden also offenbar tatsächlich Rinder und Lämmer für uns am La Plata, wobei deren Bedeutung für die uruguayischen Erzeuger entscheidend, für Deutschland und die EU allerdings eher untergeordnet ist. Genau in diesem ungleichen Verhältnis und in den auf solcher Basis gleich am Anfang falsch ausgerichteten Gehversuchen der gemeinschaftlichen Agrarpolitik sieht GAESE (1977) die Ursache der Probleme Uruguays, auf dem Weltmarkt zu bestehen. Für die 70er Jahren führt er den gerade aktuellen Importstop der EG für Rindfleisch (1974) an, dessen Folgen zusätzlich durch Maßnahmen im Rahmen der Marktordnung (Freisetzung von Interventionsbeständen) verschärft wurden. Er brachte - wie in der Folge die über 2 Jahrzehnte nicht abreißende Serie von Interventionsmaßnahmen – hoch spezialisierte Exportländer wie Uruguay in extreme wirtschaftliche Schwierigkeiten mit unübersehbaren Folgen für die Prosperität der Bevölkerung. Nicht zuletzt in der Spezialisierung auf Rindfleisch sieht GAESE

(1977) daher ein Hauptproblem der uruguayischen Landwirtschaft und mahnt eine stärkere Diversifizierung an. Gleichzeitig weist er aber auf deren geographisch bedingte Grenzen hin. Die Diversifizierung hat sich aber dennoch in den letzten Jahren als eine Teillösung der wirtschaftlichen Probleme durchgesetzt: Rindfleisch ist zwar heute weiterhin wichtigster Exportartikel, aber die 4 wichtigsten pflanzlichen Produkte (Reis, Soja, Gerstenmalz, Sonnenblumenkerne) erreichen zusammengenommen bereits 55 % des Exportwertes von Rindfleisch (einschl. Zubereitungen) und liegen jedes für sich alleine betrachtet jeweils über dem Wert von Lammfleisch (FAO). Dass die Handelsbeschränkungen, wie sie in den 70er Jahren bestanden haben, auf der Basis der WTO-Verhandlungen schon jetzt an Wirksamkeit eingebüßt haben und dies weiter tun werden, sei hier angemerkt.

Rindfleischerzeugung als Basis der uruguayischen Fleischwirtschaft

Die Fleischerzeugung in Uruguay folgt einem innerhalb des letzten Jahrhunderts relativ stabilen System. Bei praktisch kaum veränderter Weidefläche oszilliert der Rinderbestand seit 1900 zwischen 7 Mio. und 12 Mio. (*Abb. 1*). Dabei wurde ein erstes Maximum mit mehr als 9 Mio. Rindern und 24 Mio. Schafen in den Jahren von 1908 bis nach dem ersten Weltkrieg erreicht, die Truppenversorgung der kriegslustigen Europäer mit Fleisch und Wolle war Motor des Handels. Heute bewegt sich der Bestand zwischen 10 bis 12 Mio. Rindern. Besonders bemerkenswert an den langfristigen Veränderungen ist, dass das Verhältnis der Rinder zu den Schafen sich jahrzehntelang ziemlich konstant bei 1:2,5 bis 3,0 gehalten hat und erst durch drastische Umwälzungen im Schafbestand seit Ende der 90er Jahre (s. u.) auf heute 1:1,0 und weniger abgesunken ist.

Parallel zu dieser Veränderung hat der Rinderbestand, die Lücken der Schafe füllend, seit 2001 zugenommen (+ 1 Mio. Rinder). Dabei hat sich gleichzeitig das Spektrum der Kategorien stark verändert (*Abb. 2*):

- Im Wesentlichen geht die Zunahme auf Rechnung der Kälber (+ 26 %) und der gedeckten Kühe (+ 8,2 %) und damit auf die Kategorien der Bestandserhaltung. Eine entsprechende Zunahme findet sich deshalb auch bei den noch nicht marktfähigen 1 bis 2 jährigen Ochsen und Färsen (ca. + 15 %). Dass der Anteil der *ungedeckten* älteren Färsen zwar insgesamt gestiegen ist (+12 %), aber seit 2005 kräftig sinkt, ist hinsichtlich der Remonte ein positives Signal. Zusammengenommen ist die Bestandserhöhung mit einer Verjüngung verbunden.

- Alle Mastendprodukte wurden im Gegensatz dazu mehr oder weniger kräftig abgeräumt, am weitaus stärksten die Ochsen mit mehr als 3 Jahren (-26 %).

In der Nettoerzeugung von Rindfleisch (nach ZMP, FAO) nimmt Uruguay mit 0,5 Mio. t weltweit den 12. Rang ein, an der Spitze liegen die USA (12 Mio. t), Brasilien (9,5 Mio. t) und Argentinien (3,2 Mio t). Deutschland weist mit immer noch 1,2 Mio. t fast das Doppelte der

uruguayischen Erzeugung auf, obwohl ja die Rinderbestände in beiden Ländern nur wenig auseinander liegen. Der Unterschied in der erzeugten Fleischmenge macht die geringere Intensität des Mastverfahrens mit etwa der doppelten Mastdauer in Uruguay augenfällig.

Seit 1991 haben sich die Schlachtungen der Rinder stark erhöht (von ca. >1 Mio. auf >2,5 Mio.; *Abb. 3*). Der Einbruch im Jahr 2001 ist gleichsam die Narbe des damaligen Maul- und Klauenseucheausbruchs (MKS). Die Verzögerung des Abtriebs 2001 ging mit einer starken Erhöhung des mittleren Schlachtgewichtes der Ochsen um 15 kg einher, die nachfolgend wieder kompensiert wurde (INAC). In den Folgejahren seit 2002 wurden die Schlachtungen besonders forciert: Während der Rinderbestand seither nur um 9 % angestiegen ist, hat sich die Zahl der Schlachtungen im gleichen Zeitraum um 60 % erhöht. Bei diesem Anstieg ist bedeutsam, dass zunächst nur die Jungmastochsen, mit Verzögerung und dann überproportional auch die Kühe (und auf niedrigem Niveau die Färsen) beteiligt sind (Ochsen + 50 %, Kühe + 80 %; *Tab. 3*). Dass es sich dabei überwiegend um ältere (und ausgemästete) Kühe handeln muss, geht aus der grundsätzlich positiven Entwicklung des Kuhbestandes im gleichen Zeitraum hervor. Auch das Altersspektrum bei den Mastochsen ist vom Wandel gezeichnet (*Tab. 4*): der Anteil der älteren Ochsen (> 3 Jahre) nimmt bei den Schlachtungen stark zu, während die jüngeren Ochsen zuletzt gerade noch ein Drittel ausmachen. Auch dies spiegelt sich in der Bestandsentwicklung (*Abb. 2*) wieder. Eine wesentliche Ursache für die Entwicklung der Schlachtungen seit 2001 dürfte der gleichzeitige deutliche Anstieg der Erzeugerpreise sein, der auf höherem Niveau, aber ansonsten in ähnlicher Weise auch in Deutschland zu beobachten ist. In Uruguay stiegen die Preise in diesem Zeitraum kontinuierlich um mehr als 60 %, in Deutschland um 40 % an.

Das derzeitige Spektrum der Schlachtungen ist nicht durchgehend positiv zu bewerten. Die Mastochsen sind für die Gesamtproduktion die Wert bestimmende Kategorie. Wenn sich bei diesen eine Verschiebung in Richtung auf die höheren Altersklassen ergibt, so hat dies für die Qualität des Endproduktes grundsätzlich negative Folgen (s. u.). Weil mit dieser Verschiebung auch keine entscheidende Zunahme im mittleren Schlachtgewicht verbunden ist (mittleres Schlachtgewicht seit 2004 zwischen 258 und 263 kg; INAC), so steht auch wirtschaftlich in Frage, ob die längere Mastdauer langfristig tolerabel ist. Besorgniserregend ist zudem die zeitweise Konzentration der Schlachtungen auf die weiblichen Tiere. Wenn die Zuchtbetriebe langfristig mit ihren Kühen eine „Gewinnmitnahme“ betreiben, weil die Kuhschlachtung lukrativer als die Kälberproduktion ist, kann dies zu Engpässen in der Kälberversorgung führen, wie sie immer wieder sogar in der Publikumspresse in Uruguay prognostiziert werden (BÜTTENBENDER 2009; ANTÚNEZ 2009).

Lammfleischerzeugung – Nebenprodukt des Rindfleischmarktes

Seit Anfang der 90er hat sich der Schafbestand von einem Maximum von 26 Mio. (1991) auf 10 Mio. (2007) drastisch verringert, wobei das wesentliche Geschehen seit Mitte der 90er Jahre abgelaufen ist (*Abb. 1*). Die Schlachtungen, und besonders die Lammschlachtungen sind der wesentliche Motor der Bewegung, wenn auch die ersten Oszillationen des Zeitraumes von forcierten Hammelschlachtungen hervorgerufen werden. Mit vorangehenden Schwankungen erreichen die Schlachtungen zwischen 1995 und 2001 ein Maximum und fallen dann extrem rasch in das Minimum des Jahres 2003, von dem ausgehend bis 2007 eine Erholung wirksam wird (*Abb. 4*).

Der sich ergebende heftige Abbau des Schafbestandes (1997 bis 2007 - 44 %; *Tab. 5*) drückt sich unterdurchschnittlich bei den Lämmern (- 23 %) und bei den Mutterschafen (-35 %), am stärksten bei den Hammeln aus (- 74 %). Fokussiert auf den Zeitraum 2001/2007 wird aber sichtbar, dass nach dem Abstieg insgesamt wohl eine Stabilisierung eingetreten ist (*Abb. 5*). Nur der Bestand an Hammeln, die für den Export unbedeutend sind, wird offensichtlich weiter stark vermindert. Das Minimum, das sich nach 2001 bei den Mutter- und Jährlingsschafen ergeben hat, dürfte im Zusammenhang mit dem MKS-Ausbruch dieses Jahres stehen; die sehr hohen Schlachtzahlen 2001 stehen damit im Einklang: Sie schafften sehr effizient eine kurzfristige Entlastung der Weidekapazität, die wegen der ausgebliebenen Schlachtungen bei den Rindern sichtlich notwendig gewesen ist. Insgesamt ist aber das Fehlen der Schafe negativ zu bewerten und führt zu zunehmender Verbuschung der Flächen (GAESE 2006).

Die Verminderung der Tierzahl in Bestand und Schlachtung hat nur wenig Einfluss auf die letzten Endes resultierende Lammfleischproduktion. Denn im untersuchten Zeitraum steigt das mittlere Lebendgewicht der Lämmer kontinuierlich an, seit 1997 annähernd um mehr als 8 kg auf jetzt 34 kg (*Abb. 6*). Dies ist auf die seit 1996 propagierte Produktion eines schweren Lammes (>34 kg statt 24 kg lebend) zurückzuführen, das heute das leichte Lamm praktisch verdrängt hat (BIANCHI 2006). Trotz dieser Erhöhung verschlechtert sich die Schlachtausbeute nicht. Dies rechtfertigt die Annahme, dass keine Tendenz zu höherer Verfettung (größerem Anteil der Fettabschnitte) mit dem höheren Gewicht einhergeht. In der Synopse der Jahre 1997/2007 werden die Verhältnisse noch deutlicher (*Tab. 5*). Daraus zeigt sich, dass letzten Endes trotz erheblich verkleinerter Schafbestände die Produktivität der Lammfleischerzeugung sogar um ein Viertel erhöht werden konnte.

In der Nettoerzeugung von Lammfleisch (ZMP, FAO, INAC, eig. Berechnungen) hat Uruguay mit nur 30 kt (2007) weltweit keine besondere Bedeutung. An der Spitze liegen Australien (692 kt), Neuseeland (541 kt) und das VK (325 kt), Deutschland dagegen mit 44 kt wie Uruguay weit im Hintergrund.

Die aufgezeigte lang- und mittelfristige Entwicklung ist Ausdruck eines gravierenden Systemwechsels der uruguayischen Schaffleischerzeugung, die den Schwerpunkt von der Wollproduktion auf die Fleischerzeugung verlegt hat. Dass dies mit der Wertschöpfung auf dem Weltmarkt zu tun hat, zeigt sich im Gleichlauf der sinkenden Exportmenge an Wolle und dem Verfall des Wertes der Produkteinheit Wolle in den 90er Jahren auf weniger als die Hälfte des Ausgangswertes (*Abb. 7*). Entsprechend wurde die Wolle aus der Liste der 20 vom Wert her ertragreichsten Agrarexportgüter Uruguays verdrängt, während 1995 der Ertrag aus Wollexporten insgesamt noch bei 380 Mio. US$ gelegen hatte (FAO). Die Erholung der Preise seit 2002 veranlasst offensichtlich nur wenig zur Erhöhung der Produktion. Uruguay ist übrigens seither einer der größten Nettoimporteure von Rohwolle (FAO).

Exporte von Rind- und Schaffleisch

Uruguay gilt international als beispielhafter Rindfleischexporteur, dem mit der Anerkennung der MKS-Freiheit im Jahr 1996 ein international beachteter und lukrativer Wurf gelungen ist (FAO 2001). Die damals erzielte Wertsteigerung wird mit 20 Mio. US$ (Export USA) und 90 Mio. US$ (Export Pazifik-Anrainer-Staaten) pro Jahr beziffert (FAO 2001). Spitzenreiter der uruguayischen Exporte ist, nach Wegfall der Wolle und nach kräftiger wertmäßiger Zunahme von 2003 ab, unangefochten Rindfleisch, das heute praktisch ausschließlich ohne Knochen, das heißt in hochwertigen Zuschnitten, vermarktet wird. Die Exporte von Schaf-/Lammfleisch haben sich der Menge nach nicht verändert, da ja auch die Lammfleischproduktion praktisch nicht nachgelassen hat. Auch der Wert ist konstant geblieben.

Aus der Detailbetrachtung der Entwicklung bei Rindfleisch in den letzten 5 Jahren ergibt sich, dass Exportmengen zwischen 400 und 500 kt (SG) pro Jahr die vorhandene Kapazität derzeit ausschöpfen (*Abb. 8*). Dennoch steigen die uruguayischen Einnahmen aus Rindfleischexporten aufgrund der Zunahme des Produktpreises je Gewichtseinheit im betrachteten Zeitraum kräftig an. Diese Zunahme lässt sich gut mit einer stärkeren Veredelung des Produktes und der leichten mengenmäßigen Verschiebung der Exporte in die EU erklären (*Abb. 9*). In der EU werden traditionell die mit Abstand höchsten Produktpreise erzielt, in den letzten Jahren hat sich dieser Abstand gegenüber den übrigen Regionen sogar noch weiter vergrößert. Aus den verfügbaren aktuellen Daten für 2008 ist ersichtlich, dass diese Entwicklung anhält (INAC). Dennoch nehmen, zumal von der Menge her betrachtet, die NAFTA-Länder USA, Kanada und Mexico den Löwenanteil der uruguayischen Exporte ab. Die MERCOSUR-Länder Argentinien, Brasilien und Paraguay haben nur untergeordnete Bedeutung. GAESE (2006) sieht für Uruguay sogar die Notwendigkeit, sich im Export weiter von diesen Ländern zu lösen und nach neuen Wegen der Diversifizierung wie dem Export von Ökofleisch in die EU zu suchen und damit komparative Kostenvorteile besser auszunutzen. Speziell auf Deutschland gerichtet zeigt sich in diesem Kontext die Sonderrolle: Zusammen mit Spanien und den Niederlanden nehmen die deutschen Importeure besonders hochwertige Ware ab (*Abb. 10*).

Die Zusammensetzung der Rindfleischexporte zeigt einen starken Überhang der tiefgefrorenen Ware, die etwa 80 % des gesamten Exportvolumens ausmacht; die gekühlte Ware („Frischfleisch“) folgt mit 15 % (*Tab. 6)*. Die verarbeiteten Anteile (incl. gesalzen) sind von der Menge her bedeutungslos (6 % und 1 %). Der Inlandverbrauch macht gerade 40 % der Exporte an Rindfleisch aus, hat also als Konkurrenzweg der Vermarktung keine entscheidende Bedeutung. Der Rindfleischexport nach Deutschland erreicht knapp 5 % des Exports der Fleischart. Mit 57 % ist der Anteil der gekühlten Ware ausgesprochen hoch und erklärt teilweise den besonders hohen Wert der deutschen Importe *(Tab. 7*).

Der Schaffleischexport, der per Saldo reiner Lammfleischexport ist, vollzieht über die Jahre 1995/2004 betrachtet die Entwicklung der Bestände und der Schlachtungen parallel nach (*Abb. 11*). Der Verlust an Tierzahlen macht jedoch, ungeachtet der starken Oszillation in den Zwischenjahren, letzten Endes nur 9 % aus. Entsprechend dem seit 2000 mächtig ansteigenden Wert je Produkteinheit ist der Wert des Lammfleischexports im gleichen Zeitraum sogar um 67 % gestiegen. Dies ist auch auf die veränderten Produktlinien zurückzuführen. Seit 1996 wird in Uruguay die Produktion des schweren Lamms („cordero pesado“ 24 kg SG, >34 kg LG) durch die Beratung gefördert. Mit dessen Einführung als überwiegendem Produktionsziel ist die Herrichtung von Teilstücken für den Export wesentlich besser möglich geworden als die Vermarktung ganzer Schlachtkörper (BIANCHI 2006). Dies dürfte zukünftig auch eine Umstellung auf andere als Rassen als die bisher traditionell verwendeten Corriedale mit sich bringen (BIANCHI et al. 2006).

Beim Lammfleisch ist das Verhältnis der Zustandsformen des Produktes noch extremer als beim Rindfleisch: Zu fast 100 % wird das Fleisch tiefgefroren vermarktet. Dies wird insbesondere daraus verständlich, dass die Spanne der Wertschöpfung zwischen beiden Produktformen viel geringer ist als beim Rind (*Tab. 7*). Der Inlandverbrauch erreicht gerade 25 % der Exportmenge und wirkt keinesfalls beeinträchtigend auf die Lieferkapazität. Deutschland nimmt 10 % des Exports ab, davon überdurchschnittlich viel als gekühlte Ware (14 %), der Rest tiefgefroren (86 %). Anders als im Mittel der anderen Abnehmer ist beim deutschen Konvolut der Wert der tiefgefrorenen Ware höher als der Frischware[1]. Dies könnte als Anpassungsreaktion an die hochwertige tiefgefrorene Ware aus Neuseeland verstanden werden, die den deutschen Markt dominiert.

Die sehr enge Spezialisierung auf die Vermarktung von tiefgefrorener Ware bei Lammfleisch ist allerdings erst ein Entwicklung der letzten Jahre, die auch mit weiteren Veränderungen der Herrichtung der Produkte einherging; im Vergleich des Jahres 1999 gegen das Jahr 2007 zeigt sich (INAC Anuario):

- 1999 wurden noch 27 % der Produkte gekühlt vermarktet, 2007 nur noch 2 %;
- 1999 betrug der Anteil der als Schlachtkörper vermarkteten Produkte (gekühlt, gefroren) 24 %, 2007 nur noch 8%;

[1] *gilt auch für die Vorjahre (INAC anuario)*

- 1999 betrug der Anteil der als besonders hochwertig zugerichteten Teilstücke (insbes. aus dem Hintervierteil) 57 %, 2007 89 %.

Auch dieser Wandel in der Zurichtung der Teilstücke dürfte mit dem Übergang auf die schweren Lämmer zu tun haben, die sich aufgrund der Konformation und der Teilstückzusammensetzung besser für die Teilstückvermarktung eignen (vgl. BIANCHI et al. 2006).

Verbraucherakzeptanz von uruguayischem Rind- und Lammfleisch auf dem europäischen Markt

Aus der Marktentwicklung ergeben sich zwei wichtige Fragen, die auf die Qualität des Endproduktes und die Akzeptanz beim Verbraucher gerichtet sind:

- Das Schlachtalter der Ochsen hat sich in Uruguay in den letzten Jahren erhöht, da der Anteil der Ochsen mit über 3 Jahren stark zugenommen hat (*Tab. 4*). Die Zartheit des Fleisches ist mit dem Alter korreliert und erfährt selbst bei den mittelrahmigen Fleischrassen (Hereford, Angus) oberhalb von 3 bis 4 Jahren spürbare Einschränkungen (CROSS et al. 1973; REAGAN et. al, 1976; PURCHAS et al. 2002). Vor allem die abnehmende Löslichkeit des Kollagens wird für den Effekt verantwortlich gemacht.

- Die seit 1996 vorangetriebene Produktion des schweren Lamms („cordero pesado“) äußert sich in der sukzessiven Erhöhung des Schlachtgewichts seit dieser Zeit (*Abb. 6*). Das schwere Lamm ist älter als ein Jahr und gelangt damit ebenfalls in sensorisch kritische Bereiche. Insbesondere die stärkere Verfettung (BIANCHI et al. 2006) und die u. U. stärkere Ausprägung des Schafaromas könnten zu Problemen führen.

Zu diesen Fragen wurde auf uruguayische Initiative eine Serie von Studien in Deutschland, Spanien und dem Vereinigten Königreich durchgeführt, in denen die Akzeptanz von uruguayischem Rind- und Lammfleisch im Vergleich zu heimischem Qualitätsfleisch in Europa geprüft wurde (BRANSCHEID et al., 2005; FONT i FURNOLS et al., 2005; OLIVER et al, 2006). Die Untersuchungen zeigen, dass sich die deutschen Verbraucher generell positiver zur Qualität des uruguayischen Fleisches äußern als die englischen und spanischen. Dies gilt besonders für Rindfleisch (*Tab. 8*; nur Zartheit dargestellt), bei dem die deutschen Verbraucher an Teilstücke gewöhnt sind, die zu mehr als 95 % nicht gereift sind und zudem ganz überwiegend von Jungbullen stammen. Solches Fleisch ist fettarm, wenig aromatisch und selbst in den Edelteilstücken eher zäh. Folgerichtig spielt für die deutschen Verbraucher im Gesamteindruck von Rindfleisch vor allem die Zartheit eine Rolle und weniger als für die Spanier und Engländer das Aroma. Insbesondere für die Engländer scheint die gleichlaufende Beurteilung von Zartheit und Aroma (*ohne Tab.*) die unterdurchschnittliche Bewertung der uruguayischen Proben zu verstärken. Eine gesicherte schlechtere Bewertung der 3 jährigen Ochsen lässt sich dabei nicht feststellen. Zu beachten ist gerade im VK, dass die uruguayischen Proben sogar deutlich schlechter

eingeschätzt werden als die unzulänglich gereiften heimischen Proben (7 Tage Reifung). Die wenig gereiften deutschen Proben schneiden beim entsprechenden Vergleich viel schlechter ab, wohl auch weil das hier geprüfte Jungbullenfleisch es ohnedies im Vergleich zu Ochsenfleisch schwer hat.

Bei Lammfleisch ist in der Regel nicht die Zartheit, sondern das Aroma die problematische Eigenschaft. Die Clusteranalyse zeigt für die deutschen Verbraucher, dass der Gesamteindruck beim Lammfleisch in Übereinstimmung damit stärker vom Aroma bestimmt wird als von der Zartheit (BRANSCHEID et al. 2005). Grund dafür könnte u. a. sein, dass die deutschen Verbraucher an Lammfleisch und dessen spezifisches Aroma kaum gewöhnt sind: In der Untersuchung gaben sie zu 65 % an, kein Lammfleisch zu essen. In Spanien und UK lag der Anteil bei nur 3 %, während 20 % jede Woche Lammfleisch essen (DE 3 %). Gänzlich unerwartet benoten jedoch auch die deutschen Verbraucher das Lammfleisch nicht nur in der Zartheit, sondern auch im Aroma und Gesamteindruck als überdurchschnittlich gut und bewerten die schweren uruguayischen Lämmer in der Tendenz sogar besser als die leichten. In Spanien und dem VK liegen die Verhältnisse ähnlich (*Tab. 8*).

Die Untersuchungen geben also weder beim Rind- noch beim Lammfleisch Anlass, die Produktionsstrategien, wie sie sich aus der Situation der Märkte ergeben haben, grundsätzlich kritisch zu beurteilen. Lediglich gegenüber den britischen Verbrauchern ist Vorsicht angebracht. Diese sehen beim uruguayischen Rindfleisch schon in den getesteten Produkten Qualitätsnachteile und dürften eine weitere Ausrichtung der Marktanlieferungen auf noch ältere Ochsen kaum akzeptieren.

Tab. 1: Anteil der Kulturflächen an der Gesamtfläche in Uruguay und in Deutschland (Quelle: FAO)

Flächen Jahr	Fläche 2000	LN 2000	Ackerland 1980	Ackerland 2000	Dauerkulturen 1980	Dauerkulturen 2000	Weiden 1980	Weiden 2000
Uruguay								
Fläche in 1.000 ha	17.502	14.958	1.403	1.373	46	42	13.632	13.543
Anteil an der Gesamtfläche (%)	100	85,5	8,0	7,8	0,3	0,2	77,9	77,4
Deutschland								
Fläche in 1.000 ha	34.895	17.068	12.030	11.804	500	216	5.989	5.048
Anteil an der Gesamtfläche (%)	100	48,9	34,5	33,8	1,4	0,6	17,2	14,5

Tab. 2: Bestände an Rindern und Schafen in Uruguay und in Deutschland (in 1.000; Quelle: FAO)

	Zeitraum					
	1979-1981	1989-1991	1999-2001	2003	2004	1979/2004 (%)
Uruguay						
Rinder	10.965	9.046	10.446	11.708	11.700	6,7
Schafe	19.231	25.590	13.272	9.991	9.524	-50,5
Deutschland						
Rinder	20.672	20.048	14.723	13.732	13.386	-35,2
Schafe	3.209	3.912	2.879	2.823	2.285	-28,8

Tab. 3: Anteil der wichtigsten Kategorien an der Gesamtschlachtung in Uruguay (in 1.000; Quelle: INAC; eig. Berechn.)

	Mastochsen		Kühe		Gesamt
	1.000	%[1]	1.000	%[1]	1.000
2001	757	55,3	570	41,6	1.369
2002	995	60,6	603	36,7	1.642
2003	994	57,4	694	40,1	1.732
2004	1.102	51,5	991	46,3	2.140
2005	1.230	51,4	1.102	46,1	2.393
2006	1.325	51,2	1.195	46,2	2.589
2007	1.125	51,3	1.019	46,5	2.192
Veränderung 2001/2007%	49		79		60

[1] *Anteil an der Gesamtschlachtung des Jahres*

Tab. :4: Anteil der wichtigsten Altersklassen innerhalb der Gesamtschlachtung von Mastochsen in Uruguay (Quelle: INAC; eig. Berechn.)

	Altersklasse (%)[1]		
	2 - 3 Jahre	3 - 4 Jahre	>4 Jahre
2001	58,4	11,2	27,4
2002	47,1	14,7	35,8
2003	48,5	14,8	34,7
2004	43,6	16,2	37,9
2005	34,5	22,5	39,9
2006	30,6	19,6	45,5
2007	30,3	19,8	45,6

[1] *„4 dientes“ = 2,5-3 Jahre; „6 dientes = 3-4 Jahre; „boca llena“ > 4 Jahre*

Tab. 5: Veränderung der Bestände und der Schlachtungen von Schafen in Uruguay zwischen 1997 und 2007 (Quelle INAC)

	1997	2007	2007 vs. 1997
Bestand (1.000)			
Mutterschafe	8.156	5.266	-35
Hammel	3.464	909	-74
Lämmer[1]	4.135	3.174	-23
Gesamt	18.280	10.323	*-44*
Schlachtungen (1.000)			
Hammel	668	171	-74
Lämmer	887	819	-8
Gesamt	2.124	1.526	*-28*
Erzeugung Lammfleisch (t SG)[2]			
Lammfleisch	10.112	12.449	23

SG = Schlachtgewicht

[1]Milchlämmer + Lämmer< 1 Jahr

[2]Geschätzt aus Anzahl Lämmer und mittlerem Schlachtgewicht je Jahr

Tab. 6: Exporte, Inlandverbrauch und Gesamtproduktion von Rind und Schaffleisch in Uruguay (2007; in t bzw. US $; Quelle: INAC Anuario; eig. Berechnungen)

	Menge (t SG)	Betrag (US $[1])	Wert (US $/t[1])
Exporte Rindfleisch nach Zustandsform			
Rindfleisch gekühlt	56.917	228.602	5.510
Rindfleisch tiefgefroren	304.502	567.740	2.735
Rindfleisch verarbeitet	21.623	21.935	2.871
Rindfleisch gesalzen	2.329	5.167	8.669
Export Rind ges.	*385.371*	*823.444*	*3.200*
Inlandverbrauch Rindfleisch	*157.654*		
Summe Produktion Rindfleisch	*543.025*		
Exporte Schaffleisch nach Zustandsform			
Schaffleisch gekühlt	421	1.098	3.982
Schaffleisch tiefgefroren	21.352	47.747	3.092
Export Schaf ges.	*21.773*	*48.845*	*3.108*
Inlandverbrauch Schaffleisch	*7.789*		
Summe Produktion Schaffleisch	*29.562*		

SG = Schlachtgewicht

[1]bezogen auf Exportgewicht

Tab. 7: Rind- und Schaffleischexporte von Uruguay nach Deutschland entsprechend der Versandform (2007; in t bzw. US $; Quelle: INAC Anuario; eig. Berechnungen)

	Menge (t SG)	Betrag (US $[1])	Wert (US $/t[1])
Exporte Rindfleisch (Anteil D 4,5%[2])			
Rindfleisch gekühlt	3.663	26.309	12.516
Rindfleisch tiefgefroren	2.779	10.806	5.536
Export Rind ges.	**6.442**	**37.115**	**8.206**
Exporte Schaffleisch (Anteil D 10,2%[2])			
Schaffleisch gekühlt	194	559	6.143
Schaffleisch tiefgefroren	1.227	4.405	7.621
Export Schaf ges.	**1.420**	**4.963**	**7.419**

SG = Schlachtgewicht

[1]bezogen auf Exportgewicht

[2]Anteil Deutschland am Gesamtexport je Fleischart; nach Wert in US $

Tab. 8: Einschätzung des Genusswertes[1] von uruguayischem und heimischem Rind- und Lammfleisch durch deutsche, spanische und englische Verbraucher (LSQ-Mittelwerte der Einschätzungen; Quelle: FONT i FURNOLS et al., 2005; OLIVER et al., 2006)

	Uruguay		Inländisch	
	Rindfleisch - Zartheit			
	2 Jahre	3 Jahre	7 d Reifung	20 d Reifung
Deutschland (n = 200)	5,6	5,4	4,8	5,5
Spanien (n = 195)	5,6	5,5	5,6	6,1
Ver. Königreich (n = 192)	4,9	4,7	5,6	6,1
	Lammfleisch - Aroma			
	leicht	schwer	7d Reifung	20 d Reifung
Deutschland (n = 200)	5,9	6,1	6,3	6,4
Spanien (n = 200)	5,6	5,4	5,6	5,4
Ver. Königreich (n = 200)	5,4	6,1	6,1	6,2

[1]Skala 1 (außerordentlich schlecht) bis 8 (außerordentlich gut)

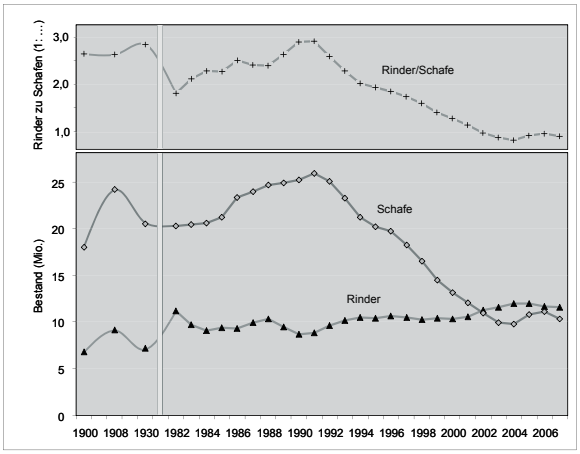


Abb. 1: Bestände (Mio.) an Rindern und Schafen in Uruguay und Verhältnis des Rinder- zum Schafbestand (1: ...; Quelle: INAC, BACKHAUS und DIAZ, 1907; GIUFFRA 1935; eig. Berechn.)

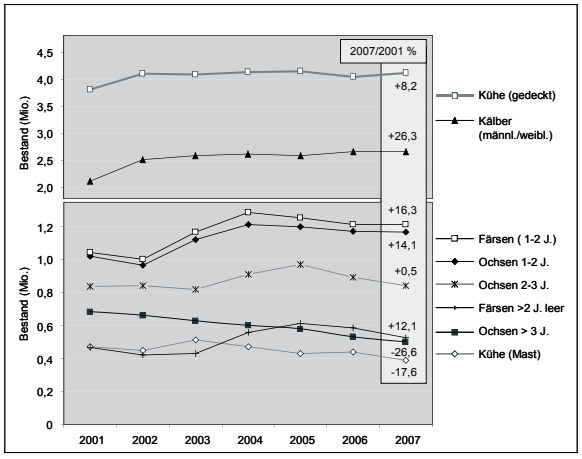


Abb. 2: Veränderung des Rinderbestandes zwischen 2001 und 2007 (in Mio.; Quelle: DI.CO.SE; eig. Berechnungen)

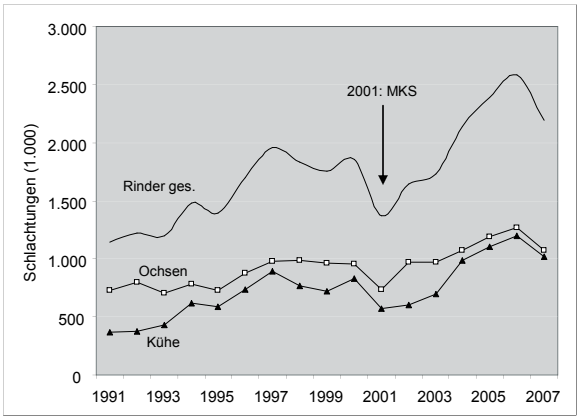


Abb. 3: Schlachtungen von Rindern in Uruguay (Jahresmittelwerte in 1.000 Stück; Quelle: INAC)

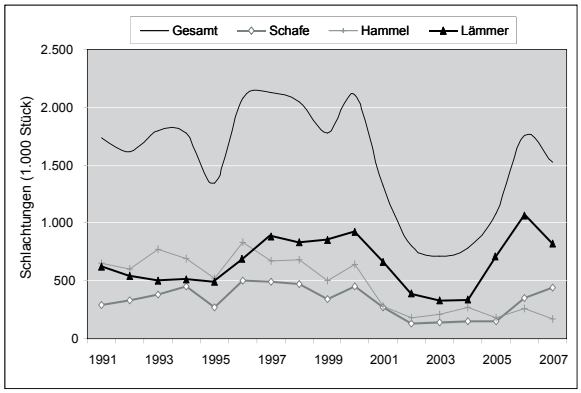


Abb. 4: Schlachtungen von Schafen in Uruguay (Jahresmittelwerte in 1.000 Stück; Quelle: INAC)

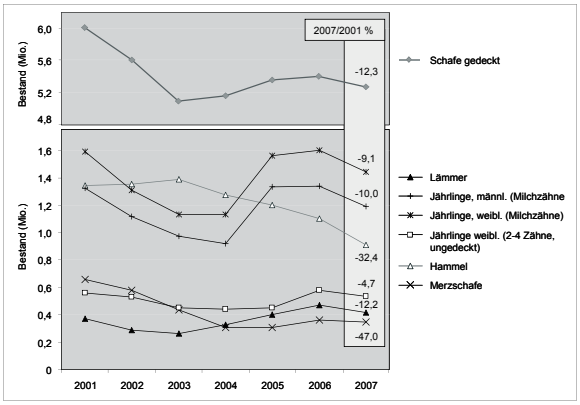


Abb. 5: Veränderung des Schafbestandes zwischen 2001 und 2007 (in Mio.; Quelle: DI.CO.SE)

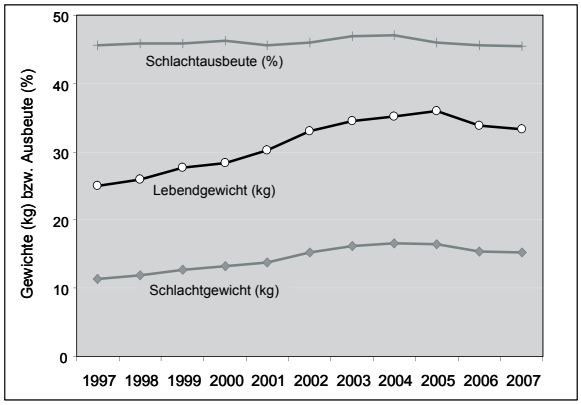


Abb. 6: Schlachtungen von Lämmern in Uruguay: Lebend- und Schlachtgewicht sowie Schlachtausbeute über die Jahre von 1995 bis 2007 (Gewichtete Jahresmittel; Quelle: INAC)

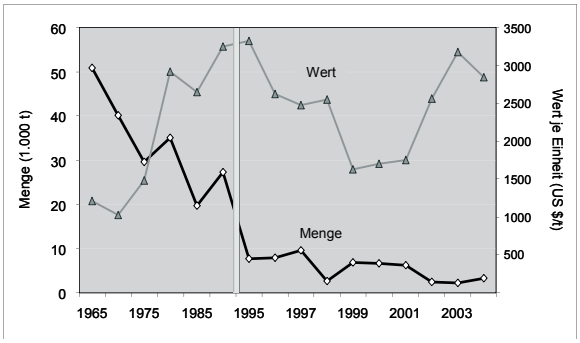
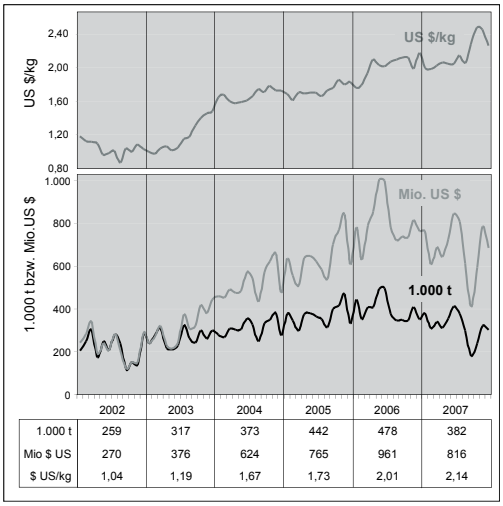


Abb. 7: Menge der von Uruguay exportierten Schafwolle (Rohwolle) und Wert je Gewichtseinheit (Jahresmittelwerte in 1.000 t bzw. US $/t; Quelle: FAO)



	2002	2003	2004	2005	2006	2007
1.000 t	259	317	373	442	478	382
Mio $ US	270	376	624	765	961	816
$ US/kg	1,04	1,19	1,67	1,73	2,01	2,14

Abb. 8: Exporte von Rindfleisch (Monatsmittelwerte;1.000 t Schlachtgewicht und Mio. $ US – jeweilige Preise; Quelle INAC, eig. Ber.)

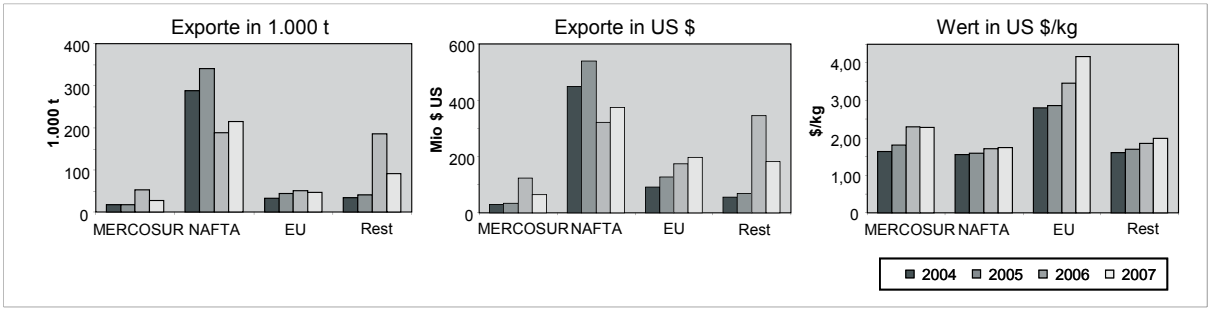


Abb. 9: Exporte von Rindfleisch in die Exportregionen (1.000 t und US $ - jeweilige Preise) und der Exportwert je Produkteinheit (US $/kg). (Quelle: INAC, eig. Ber.)

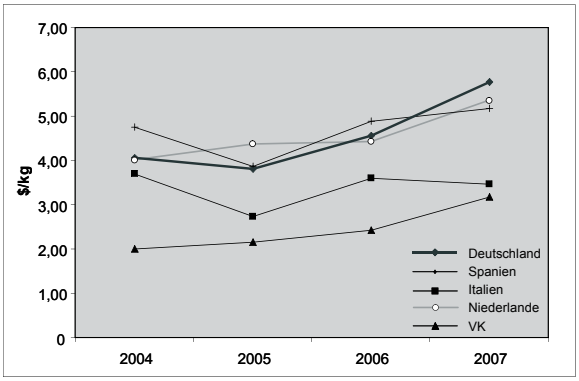


Abb. 10: Wert der uruguayischen Exporte von Rindfleisch in die wichtigsten EU-Mitgliedstaaten (US $/kg) (Quelle: INAC, eig. Ber.)

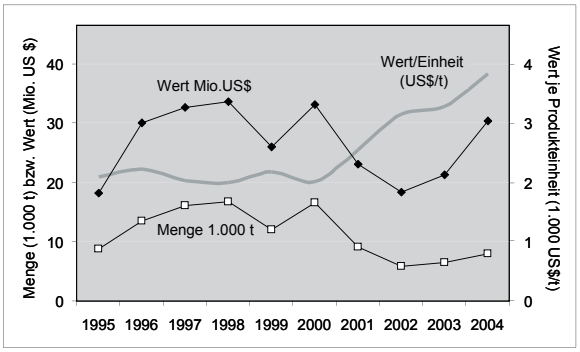


Abb. 11: Menge und Wert der Exporte von Schaffleisch aus Uruguay (in Mio. US$ - jew. Preise - bzw. 1.000 t; Quelle: FAO)

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Technology transference and participatory training to increase profitability of microenterprises in the Petorca province of Chile

Prof. Dr. Eduardo Salgado and Ing. Agr. Nieggiorba Livellara

Introduction

Creating conditions which allow opportunities to be seized and the transformation of family agriculture (FA) into a system of microenterprise agriculture is a great challenge. In Chile, FA represents 84% of farms (in land), with 53% from microenterprises with differing levels of development, and 31% subsistence farming (National Agro-livestock Census, 2007). The Petorca province presents a situation similar to the national average, with a slightly higher percentage of family agriculture (89%) and a slightly lower percentage of subsistence agriculture (25%). Consequently, the area takes on relevance both nationally and regionally, and as such improvements in its productive systems would affect the economy of a wide sector of the rural world as well as increasing the quality of life of the families involved.

It is estimated that on a global level the problems of microenterprises are mainly associated with intensifying and consolidating their production. Inasmuch as there exist obstacles which must be removed, or at least mitigated, there are also missed opportunities, due to both the drawbacks of the system and its own limitations. In the case of subsistence farming, on the other hand, the problems are concentrated on the barriers which exist to accessing the production system. The limited availability of resources (land, capital and work) impedes participation in the conventional agricultural model. Consequently, generating opportunities for development in this sector is only possible by forming innovative models which imply (1) adaptation to the available resources, (2) high levels of intensification of the use of these resources, (3) final products with high added value and, (4) the forming of associations for management and sale. The program described here is therefore focussed on (1) finding and developing opportunities, (2) consolidating strengths while dealing with weaknesses and, (3) foreseeing and avoiding the dangers which affect agricultural microenterprises in the Petorca province. The final goal was to generate routes for the development and consolidation of the microenterprises and subsequently improve their profitability.

2 Characterisation of the study

2.1 Characterisation of population and production

The Petorca province is located in the far north of the Valparaiso Region, Chile. It has an area of 4,588.9 km² and a population of 70,610 inhabitants. The provincial capital is the city of La Ligua. It is the largest province in the Region (Figure 1).

Figure 1. Petorca province

28.78 % of the inhabitants live in rural areas (Table 1), putting it well above the regional average (8.4%). The rural population is mainly situated in the sectors of La Ligua, Cabildo and Petorca, representing 94% of the total province.

More than 50% of the total population, urban and rural, fall into the age range of 20 to 60 years (Figure 2); this is the segment of the population on which this project focuses its efforts.

Table 1. Urban and Rural Population of the Petorca province

Sector	Inhabitants		Sex	
	Urban	Rural	Men	Women
La Ligua	24,214	7,773	16,079	15,908
Cabildo	12,453	6,463	9,466	9,450
Petorca	4,535	4,905	4,806	4,634
Papudo	4,343	265	2,382	2,226
Zapallar	4,744	915	2,014	2,745
Total	70,610		34,747	34,963

Source: Population and Residential Census, 2002

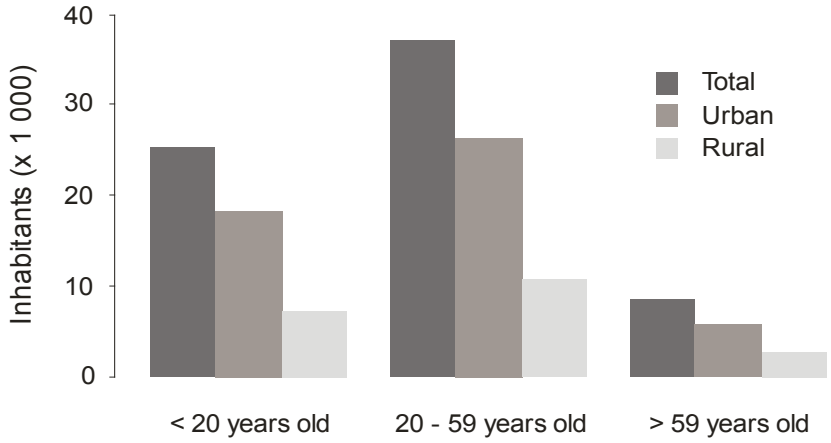

Figure 2. Distribution of the total population, urban and rural, according to age range. (Population and Residential Census, 2002).

In the province, 51% of the total surface area used in production is classified as large exploitations, while 28% is cultivated by small enterprises. The main areas of large exploitations are fruit and fodder. Horticulture, flowers and seeds are more characteristic of the medium and small cultivations. The agricultural microenterprises tend to do business based on the short term, characterised by requiring a lower initial investment, short production cycles, needing shorter periods to recover the initial investment and obtain return, high vulnerability of productive results, and a high sensitivity to variations in supply and demand in the market.

2.2 Climatic characterisation

Five agro-climatic districts may be identified in the Petorca province (Figure 3), whose characteristics are described below in Table 2.

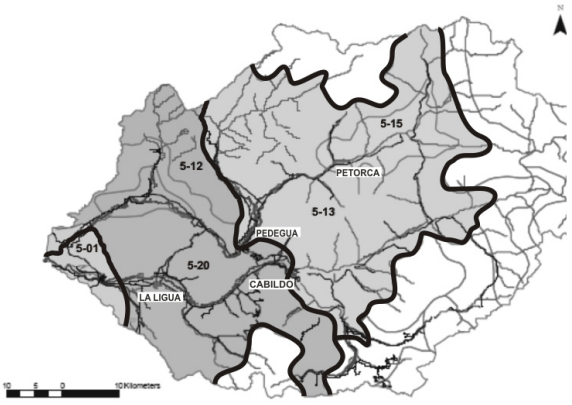

Figure 3. Agro-climatic map of the Petorca and La Ligua river valleys. (Source: National Irrigation Commission, Valparaíso Region)

Table 2. Characterisation of the agro-climatic districts of the Petorca and La Ligua river valleys

Characteristics	Agro-climatic districts				
	5.01 Cs5.73/H 0 10	5.12 BS-15.83/H 0 10	5.13 BSg2-15.82/H 0 10	5.15 BSg2-15.82/H 0 9	5.20 Csg1-15.83/H 0 10
Location	Coast	Coastal mountains	Inland mountains	Inland valley	High mountains
Temperature, °C	23.5 – 7.9	27.2 – 6.9	28.2 – 4.6	29.2 – 4.0	27.4 – 6.1
Frost-free period, d year	365	365	240	224	339
Degree-day, day	1,630	1,861	1,780	1,932	1,682
Cold hours, h	166	316	895	940	612
Precipitation, mm	354	270	263	220	447
Water deficit, mm	837	1025	1.085	1.156	949

3 Education strategy

This program presents an education strategy focused on the small farming producers, taking into account the presence of different educational levels and age ranges, as well as the various commercial, economic and productive interests involved. Therefore, the teaching methodology that was used had a constructive and participatory focus, adapted to the reality of each work group.

The design considered the permanent education of all the human resources of the program through downward transference. In practical terms, the consultants[3] taught *in situ* and based lessons on the practical experiences of the professionals[4]; so they could later pass this knowledge on to technicians[5] in courses, workshops and site supervision visits. Subsequently, the technical team gave instruction to the agricultural micro-entrepreneurs belonging to the Interest Groups[6]. This multiplying design was considered in response to the objective that the highest possible number of participants had access to the knowledge on offer and thus be in a position to replicate and broaden their experience, converting the project execution process into a continuous learning experience.

The farmers belonging to one particular Interest Group defined the subject matter themselves based on their own needs, and activities were organised which were able to respond to these needs. The big advantage of this system is that it responds directly to the motivation of the farmers. This was carried out through workshops on predefined educational themes; themes which were defined jointly with the farmers, and from which a work plan was established, considering a series of activities designed to achieve the self-imposed goals of the workshop, and leading to agreements and commitments between the program and the participants (Figure 4).

[3] *Consultant, specialised professional*
[4] *Professionals, agricultural engineers responsible for the program on site*
[5] *Technicians, intermediate level personnel*
[6] *Interest group, micro-entrepreneurs interested receiving education in a certain area and that are prepared to commit to participating actively in the group.*

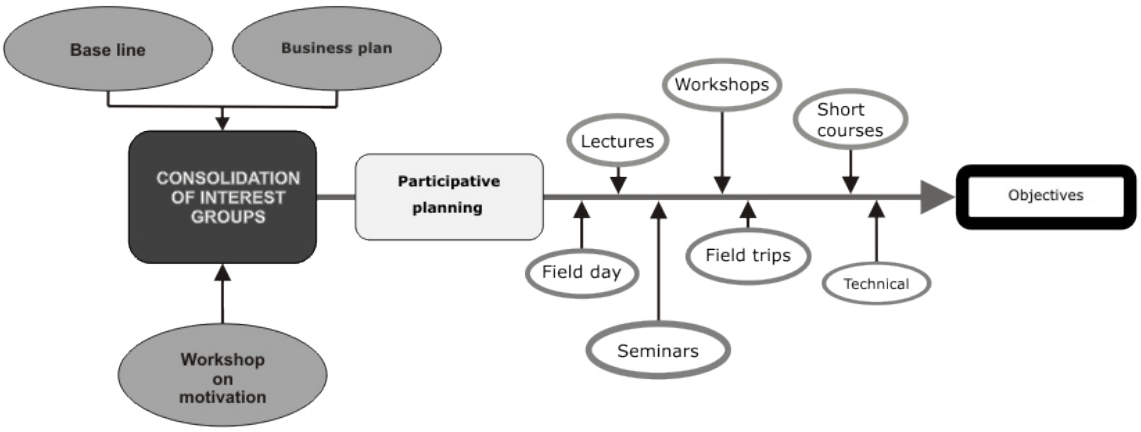

Figure 4: Participatory planning diagram.

4. Validation strategy

4.1 Sample plot selection methodology

In order to select the validation plots, agro-climatic information was contrasted with edaphic information, using a geographic information system; the process was carried out by the Institute of Technology for the Tropics (ITT) of the Cologne University of Applied Sciences in Germany. Once the most representative areas of the district climate were established in terms of agricultural importance, meetings were organised in order to visit the areas selected and receive different testimonies from the corresponding community: authorities, consultants, professionals and farmers. The objective of these meetings was to reach agreements with private and educational institutions, with the aim of investing in the area and also to ensure continuity over time.

4.2 Crop selection methodology

In order to select the species and varieties to be planted, the edapho-climatic characteristics of each district were compared with the requirements of different species and crops, along with market information and marketing alternatives. Finally, the proposal was distributed among the governmental entities related to agriculture in the zone, and among the farmers themselves. Fruit tree crops were planted (grapes, apricots, walnuts, cherries, oranges, mandarins, olives, medlars and lucuma), along with horticultural crops (melons, potatoes, strawberries and physalis), and flowers (fabanas, gerberas, lavender). In each plot it was verified that the crops were able to adapt to the agro-climatic conditions of the district. This was done my measuring vegetative growth and productive variables of the plants, whilst recording climatic variables using automated weather stations installed in each validation plot.

The validation of the crops was analysed from three different perspectives; (i) technical, (ii) economic/commercial, and (iii) with respect to the efficiency of water use. The analysis of the results was performed for each location and for each crop separately. In the first case (i) a comparison was made of the results observed for all the crops. In the second case (ii), the results obtained for each were compared between the locations where the particular crop had been planted. However, in these cases a similar analysis was also carried out on the response of the crops in the locations, comparing the results with historical records.

The comparison of the results for the validated crops from each location was performed using three indicators. Profitability, expressed as a percentage, which was determined as the ratio of the net profit and total costs. Income was calculated as the product of productivity and sale price, while total costs were the sum of production costs and annual investment. Annual investment was calculated from the total initial investment per hectare for each crop and the corresponding depreciation, which depends on the type of investment. This indicator may be used to determine the economic efficiency of each production system, with a business being classified as profitable when the indicator is positive.

Since this program is focused on FC, the analysis considered the level of costs associated with each crop as a second limiting factor, allowing differentiation between two different crops of a similar level of profitability. Finally, the economical efficiency of water usage was considered for each crop, defined as the ratio of income to amount of water applied, expressed as %/litre. A joint analysis of these three indicators, along with technical production information, enabled the determination of the species and crops which were recommended and not recommended for each validation unit.

4.3 Determining the profitability of the agricultural microenterprises

The economic results of the participants of the program were established based on the change in the profitability of their agricultural businesses. In order to quantify this change the initial and final profitability of the farmers was identified. To find the necessary information for determining this variation, semi-structured surveys were carried out individually and in groups. The analysis was made of a sample of 114 farmers from a total of 800 who participated in the program (14.3%).

The profitability allows identification of the benefit generated in relation to the investment. To calculate the profitability of the agricultural microenterprises, the following equation was used:

$$\text{Profitability} = \frac{\text{Net Profit}}{\text{Total Costs}} = \frac{\text{Income} - \left(\text{Direct costs} + \text{indirect costs}\right)}{\text{Direct costs} + \text{indirect costs} + \text{annual investment}}$$

By analysing the information compiled from the surveys it was determined that the indirect costs and the annual investment of the microenterprises do not vary, therefore the formula above may be simplified and profitability may be expressed in the following way:

$$\text{Profitability} = \frac{\text{Gross Profit}}{\text{Direct Costs}} = \frac{\text{Income - Direct Costs}}{\text{Direct Costs}}$$

Where:

$$\text{Income} = \text{productivity} \times \text{sale price}$$

$$\text{Direct costs} = \text{materials} + \text{labour costs} + \text{machinery rental}$$

In the profitability estimation for the farmers, the income and the direct costs are expressed in $/hectare, whereas for apiculture they are expressed as $/beehive.

5. Results

5.1 Validation results

74 species, crop and location combinations were evaluated and conclusions were possible in 71% of cases. The conclusions were classified as recommended crops (23%), recommended with observation (8%) and not recommended (40%). In 29% of cases it was found that there was a lack of information in order to be able to recommend or reject a certain species and/or crop. This occurred mainly with the fruit trees, since they are in their fourth year since planting and have not yet reached maximum production. A summary of the results per validation unit for all species and/or crops is shown in Figure 5. Additionally, for each crop a technical, economic and commercial report was prepared.

5.2 Increase in the profitability of the agricultural microenterprises

The objective of this program was to increase the profitability of agricultural microenterprises in the Petorca province via cost reduction, an increase in production and/or improvements in the sale price. Figure 6a shows the percentage of farmers who experienced a favourable change in these parameters.

The program achieved a variation in profitability in 40% of the participating farmers. The training activities allowed favourable modification of the three profitability parameters, but not to the same degree. It may be seen in figure 5.2b that only 3% of farmers showed improvements in all parameters, however, 83% of farmers managed to improve at least one parameter, which is a significant achievement for a technology transference program such as this.

Species	Variety	CHINCOLCO	LA CANELILLA	LA HIGUERA	LA VEGA	PUYANCON	LONGOTOMA
Potatoe Chilota	Clavela	○			●	●	
	Var 2	○			○	●	
	Guadacho Blanco	○			●	○	
	Guadacho Colorado	○			●	●	○
Melon	Yuma Grande	○	●		●	○	
	Otero	○	○		○	○	
	Honey Dew	○	●		●	●	
Estatice	Quis	○	▨		●	●	○
	Fortress	○	▨		●	●	○
Physalis	Physalis	●	●		●	▨	▨
Strawberry	Aroma	○	●			○	
Gerbera	Gerbera	○	○				
Fabiana	Fabiana	▨					

Species	Variety	CHINCOLCO	LA CANELILLA	LA HIGUERA	LA VEGA	PUYANCON	LONGOTOMA
Olive	Sevillana	●					○
	Picual	●		●			○
	Barnea	●		●			○
	Leccino	●		●			○
	Arbequina	●		●			○
Mandarin	Clemenules	○		○			
Orange	Lane Late	○					
Nut	Chandler	●					
	Serr	●					
Cherry	*all*	●					
Wine grape	Cabernet Sauvignon	●					
Peach	Modesto	●					
	Dina	●					
	Palstein	●					

Figure 5: Species and/or crops: validated, recommended, recommended with observation, insufficient information to recommend and not recommended per validation unit in the Petorca province.

● Recommended crop

▨ Recommended with care

● Not enough information

○ Not recommended

Increases in sale price were achieved by 52% of farmers. This increase must be understood as the result of developing new products for them (olive oil, bouquets of flowers), improvements in sales channels (walnuts, flowers) and normal price variation (mainly in avocado). Cold spells and drought experienced in the central zone of Chile lowered the supply of farming produce and provoked a general rise in prices.

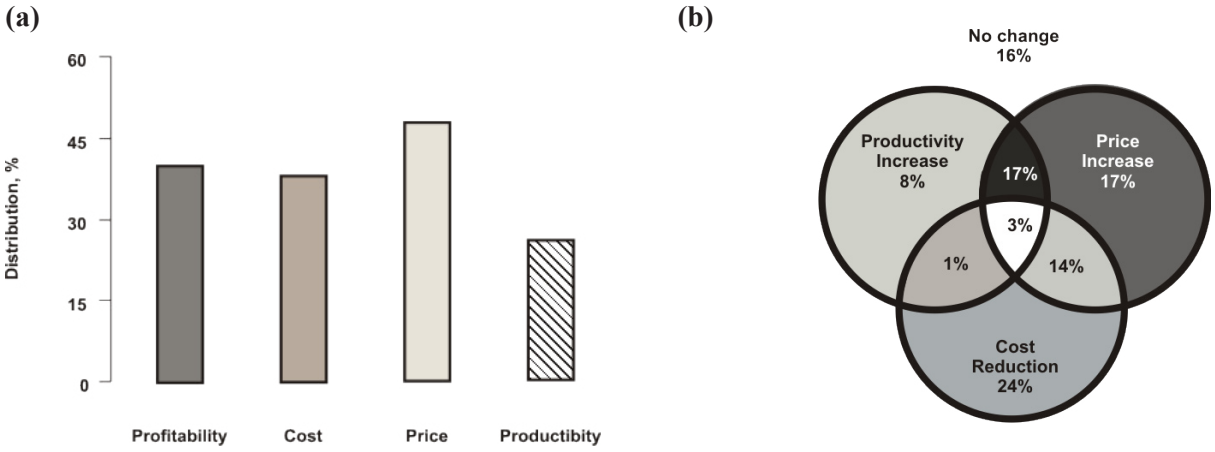

Figure 6. Percentage distribution of farmers who reported favourable variation in economic variables for the period 2007-2008

6 Conclusions

Global evaluation of the program demonstrates that: (a) quantification of the impact of the program, based on variation in farming profitability, represents a significant methodological innovation for technology transference, which usually only considers qualitative indicators; (b) the methodology of carrying out a work plan, based on the group interests of the Interest Group, is broadly successful in terms of gaining the commitment of the farmers to active participation.

Finally, other programs of this sort should be tested in other sectors of family agriculture, in order to validate the results obtained in this project.

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Plants are not weight watchers but space invaders

Prof. Dr. Marc J.J. Janssens, Prof. Dr. Jürgen Pohlan, Prof. Dr. Norbert Keutgen
& Dr. Juan Carlos Torrico

Introduction

Most plant growth parameters refer to weight indicators. Thus, in agriculture, final output will be compared in weight/unit of surface. If not in weight units, most growth models equate growth in two dimensional units like leaf area index or basal area. However, foresters use volume units, but then only for the harvestable part i.e. the stem. In nature, such a competition for weight does not exist, but rather for space, as can be seen with root development of *Sesbania sesban* (Figure 1). Space development and energy content of different agro-ecological systems have been described by Torrico (2006). Species survival actually alternates phases of spatial invasion with periods of energy concentration. In this contribution, three dimensional spatial development of the whole vegetation will be highlighted.

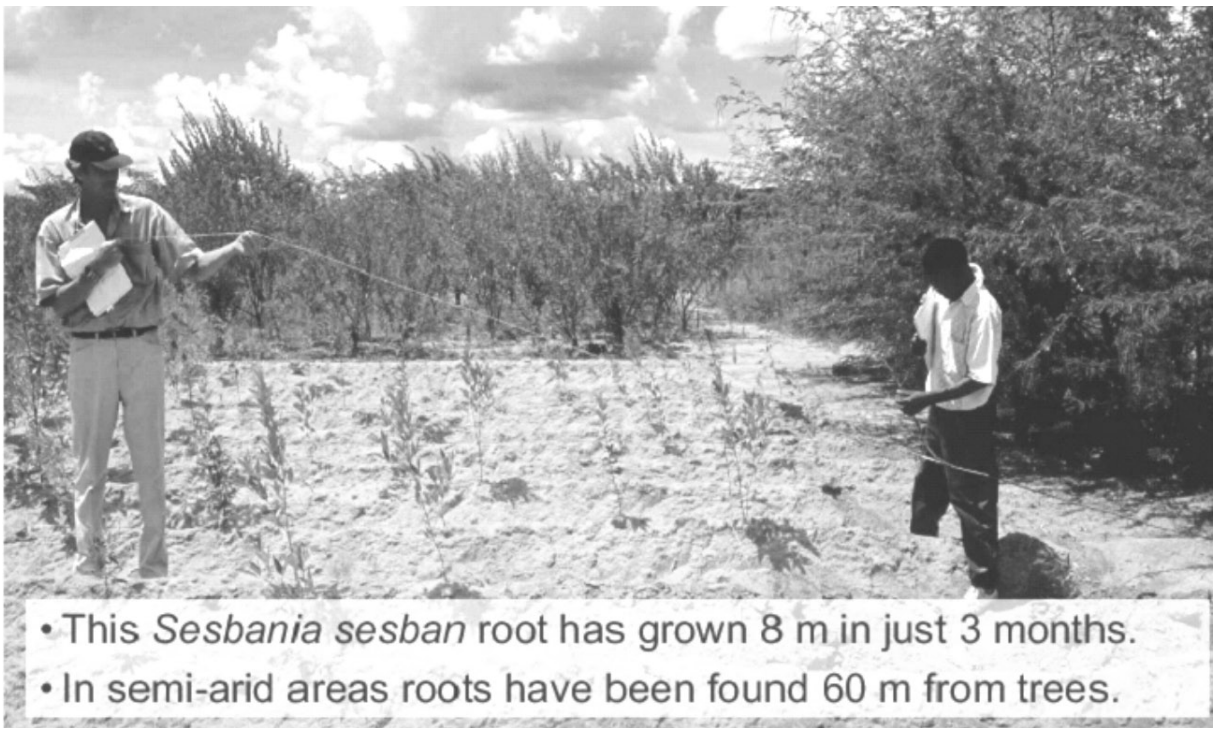

Figure 1: Spatial invasion of a sesban root . Source: ICRAF, Nairobi, Kenya

Eco-volume (V_{eco}) and Bio-volume (V_{bio}) to characterize a 3-dimensional vegetation space

Basic input data for the spatial development of vegetation are *eco-height (h_{eco})* and *basal area (BA)* for each category of the land and farm use. For of one of the latter categories, eco-height is the average vegetation height weighted in time and for each of the vegetations within category community area variations (Figure 2).

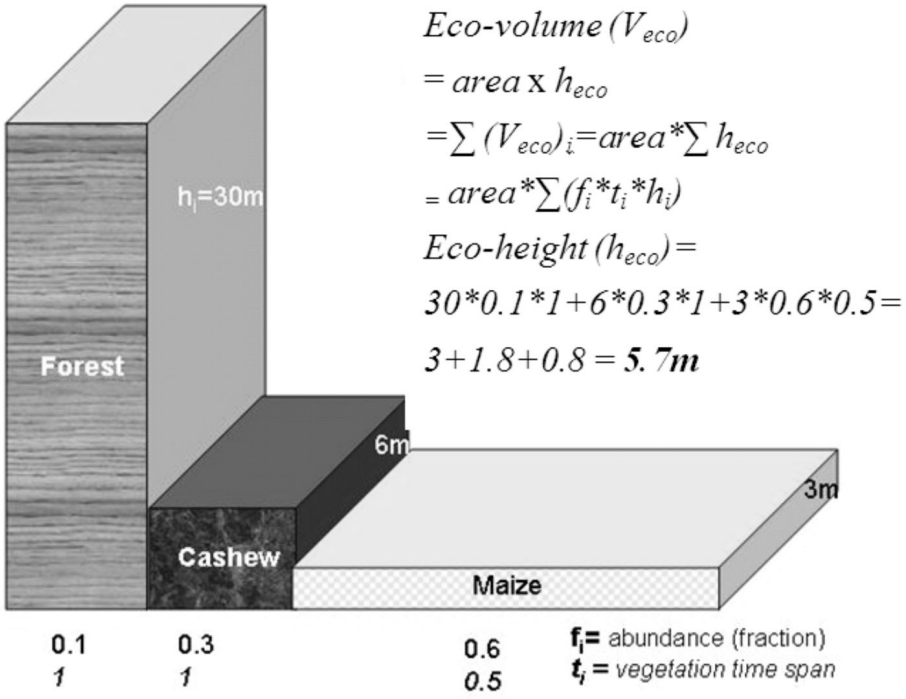

Figure 2: Fictive example of weighted eco-volume calculation

The basic output data are easy to calculate, where

bio-volume (V_{bio}) = BA x h_{eco}

and

eco-volume (V_{eco}) = area x h_{eco} (Figure 2).

The concept of eco-volume gives a three dimensional dimension to a vegetation stand. The weighted height is also called eco-height as it characterizes the importance of the colonized space (Janssens et al. 2004).

Wesenberg coefficient (W)

This coefficient is the ratio of eco-volume to bio-volume in m^3/m^3:

$W = V_{eco}/V_{bio}$

The Wesenberg coefficient describes the ability of a vegetation system to colonize space.

Crowding intensity (C)

The crowding intensity is the inverse of the Wesenberg coefficient expressed as a percentage:

$$C = 1/W = (V_{bio}/V_{eco})100$$

The crowding intensity is a measure of vegetation or bio-volume density within a given space. Agricultural systems will tend to have higher crowding intensities, leading towards a higher harvest index and a higher disease pressure.

From an ecological point of view it is expected that the most adapted system tends to develop the highest unit eco-volume. For agricultural purposes, the amount of the actual harvested product of interest will be optimized per unit of external input. Management practices will then neglect the non-harvested biomass portions. Hence, at optimal agricultural development level or agro-climax (Janssens et al. 2006), eco-volume will be seriously reduced for better economic return.

The relation between eco-volume and bio-productivity is illustrated in Table 1 by a six-year experiment with sugar cane in Chiapas, Mexico (Toledo et al. 2004 in Janssens et al. 2005). Green cane develops the largest eco-volume, the largest bio-volume and, eventually the largest energetic production not only on a per ha basis but also per unit of available eco-volume. It all confirms that green cane follows the maximum power law (Odum 1969).

Table 1: Estimates of eco-volume and bio-volume in Mexico, Chiapas, Huixtla (average of 6 years)

	Yield (fresh matter in t/ha/year)			**Biometrical characteristics of sugar cane stand**					
	Cane	Cane tops	Total	Eco-height (d)	Basal Area (BA) m²/ha	Eco-volume V_{eco} (m^3/ha)	Bio-volume (m³/ha) = BA * d	Wesenberg (w) (V_{eco}/V_{bio})	Crowding intensity C_i = 100/w (%)
Green cane	125	18.7	143.7	2.46	131.0	24600	322.3	76.3	1.3
Burn 1x	96	14.4	110.4	2.09	97.5	20900	203.8	102.6	1.0
Burn 2x	89	13.3	102.3	1.97	72.3	19700	142.4	138.3	0.7
	Dry matter yield (t/ha/year)			Energy content					
	Cane	Cane tops	Total	MJ/kg dry matter	Yield (GJ/ha) Output	Yield (GJ/ha) Loss	MJ/m^3 eco-volume	MJ/m^3 bio-volume	
Green cane	41.7	6.3	48	18.0	864	0	35.1	2681	
Burn 1x	32.0	4.8	36.8	18.0	662.4	201.6	31.7	3250	
Burn 2x	29.7	4.5	34.2	18.0	615.6	248.4	31.2	4323	
					Maximum power law			**Agricultural concentration**	**Bio-industrial concentration**
Concentration path									
Site	Atmosphere				**Eco-volume**	**Bio-volume**		**Harvest index**	**Bio-ethanol**
Active ingredient	CO_2 350 ppm				**$(CH_2)n$**				**C_2H_5OH**
Energy status	0 MJ/m^3				**> 30 MJ/m^3**	**> 2500 MJ/m^3**			**22600 MJ/m^3 (or 1000 l)**

Source: Estimated after yield data from Toledo et al. 2004 in Janssens et al. 2005

Bio-productivity is space-related

When neglecting the efficiencies of different photosynthetic pathways with respect to water and nitrogen use, the efficiency of plant growth has been estimated on the base of usual dendrometric parameters (Figure 3).

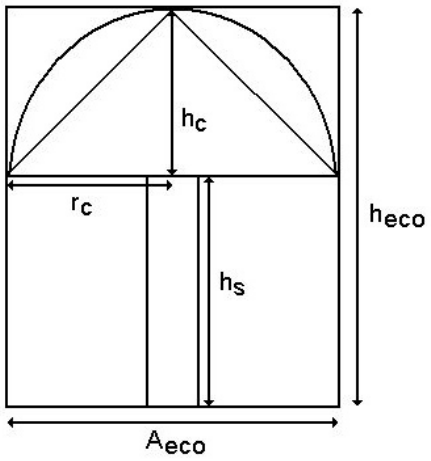

Figure 3: Abbreviations used for the calculation of plant growth efficiency (E_{gr}) - Keutgen in Janssens et al. 2008

It has been shown that efficiency of plant growth (E_{gr}) can be expressed as

$$E_{gr} \sim V_{bio} \times h_c / h_{eco}$$ *(Keutgen in Janssens et al. 2008)*

The ratio h_c / h_{eco} is at maximum, if $h_c = h_{eco}$. In consequence, the optimal morphotype of a plant, reflecting optimal plant growth, is represented by a kind of compact, 'bushy' appearance. The same relationship is in principle valid for ecosystems. The ideal morphotype is, however, modified by local strains, to which plant specimens and plant communities have to adapt. This adaptation usually results in a reduction of plant growth efficiency (E_{gr}). For example, the combined heat, drought and excessive light stress of a desert climate results in a reduction of canopy area, while competition for light results in an increase of stem-height and eco-height (h_{eco}).

Agricultural plants follow in their growth behaviour the same principles of efficiency. However, due to agricultural practice the competition of plants for light is minimized. As a consequence, growth efficiency (E_{gr}) of agricultural plants in agricultural ecosystems may be larger than in plants of natural ecosystem.

The investment of metabolic energy into height-growth of plants is minimized, as indicated by a reduction of eco-height (h_{eco}), stem-height (h_s) and an increase in crown-height (h_c), so that, in the ideal case $h_c = h_{eco}$. It can, thus, be concluded that agricultural plants are 'efficiency optimizers', while plants dominating natural ecosystems are frequently typical 'space invaders' (Janssens et al. 2008).

Efficiency of spatial colonisation determines growth efficiency

Different ways chosen by plants under different agro-ecological conditions ensure species survival and perpetuation. Under difficult situations plants will try to develop highly specialized reserve organs with highly concentrated energy storage means. When considering eco-volume as a major characteristic of each crop morphotype or each vegetation type rather than biomass, it follows that energy and input flows should be divided by eco-volume. How large an eco-volume can be developed per unit of water or per unit of solar input and this for each season within a year?

a. The principle of maximum power holds per unit of 2-D area

Natural systems are believed to evolve towards entities being most efficient at capturing energy:

"…in the struggle for existence, the advantage must go to those organisms whose energy-capturing devices are most efficient in directing available energy into channels favorable to the preservation of the species" (*Lotka 1922a, p. 147);*

"...it seems appropriate to unite the biological and physical traditions by giving the Darwinian principle of natural selection the citation as the *fourth law of thermodynamics*, since it is the controlling principle in rate of heat generation and efficiency settings in irreversible biological processes" (*Odum 1963, p. 437);*

"...it may be time to recognize the maximum power principle as the fourth thermodynamic law as suggested by Lotka" (*Odum 1994);*

"The maximum power principle can be stated: During self organization, system designs develop and prevail that maximize power intake, energy transformation, and those uses that reinforce production and efficiency" (*Odum 1995, p.311).*

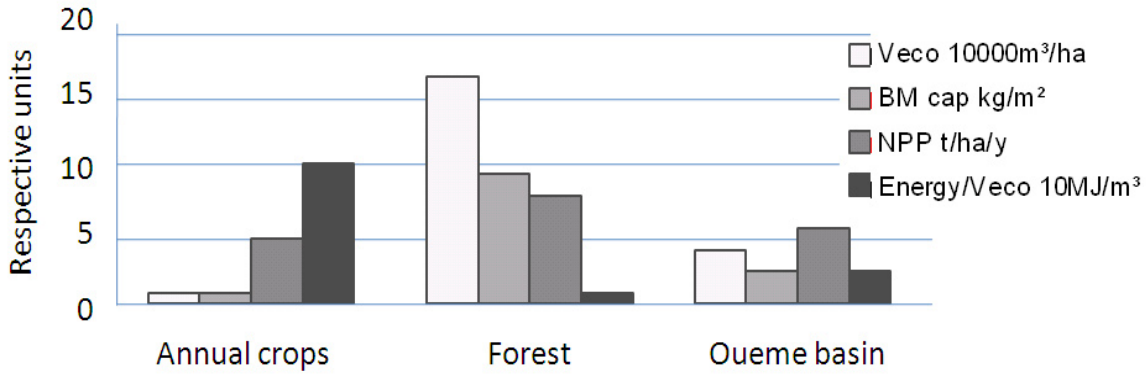

Figure 4: Energy allocation in agro-ecological systems is in fact spatially bound

This theory could be verified in Benin by comparing biomass capital and yearly netto primary production (NPP) of annual crops vs. forest stands in the Oueme Basin (Figure 4). The weight-related parameters are all pointing to forest being the best accumulator and producer of energy on a surface basis i.e. on a two-dimensional basis. In fact, agro-ecological systems are not a construct of weight projected on a two-dimensional plane. They are actually representing a bio-volume, itself colonizing a three-dimensional box.

b. The principle of minimum energy holds per unit of 3-D space

"The principle of minimum energy is essentially a restatement of the second law of thermodynamics. It states that for a closed system, with constant external parameters and entropy, the internal energy will decrease and approach a minimum value at equilibrium. External parameters generally means the volume, but may include other parameters which are specified externally, such as a constant magnetic field" (Wikipedia, the free encyclopedia, 2009).

When expressing energy captured by agro-ecological systems in the Oueme Basin, Benin, one is struck by the fact that forest vegetation contains less energy per unit of eco-volume (Figure 3). In other words, the natural vegetation tends to evolve towards maximizing its eco-volume at least energy per unit. In fact, plant growth is based on balancing a maximum eco-volume with a minimum energy.

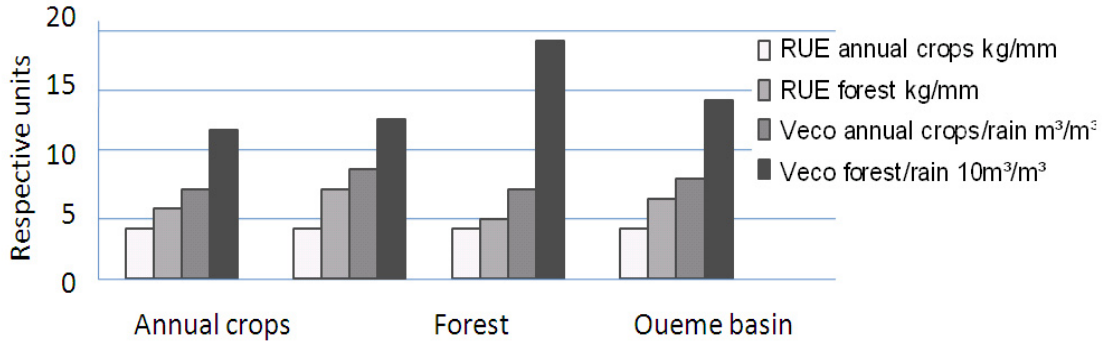

Figure 5: Rain use efficiency and eco-volume/rain rate in the Oueme basin, Benin

Agricultural domestication alternates concentration with dilution of natural resources

Domestication of natural systems into agricultural systems encompasses concentration of energy within space i.e. reducing the eco-volume for a same bio-volume or increasing both the bio-volume and the Wesenberg coefficient. This rationale has been followed by most sugar cane growers throughout the world by burning sugar cane twice for each harvest enabling them to reach a Wesenberg coefficient of 138.3 as compared to only 76.3 for the unburned treatment (Table 1). It further resulted in a harvestable cane with larger energy content (4323 MJ/m³ bio-volume) than that of green cane (2681) by reducing the relative importance of leaves to cane stalks. By doing so 248.4 GJ/ha/y are lost (Table 1) just for the sake of concentrating harvestable energy easily.

From an energetic point of view, agriculture is an alternating concentration/dilution process. Yet, farmers concentrate natural resources (water, manure, plastic tunnels, etc.) in a very efficient way and subsequently dilute them over the field as efficiently as possible.

- South of the Sahara the efficiency of the agricultural concentration-dilution dialectic process (binome) is poor, resulting in a mining type of agriculture with frequent bush fires and poor interaction between animal and crop husbandry. The dilution of natural resources like water, fertilisers etc. is the most critical step in agriculture.

- In Mexico, sugar cane farmers developed an agro-climax (Janssens et al. 2006) where harvestable energy is concentrated by diminishing eco-volume and raising the cane to leaf ratio by double burning.

- In Benin, forest vegetation as compared to that of annual crops deploys an impressive eco-volume per unit of energy (Figure 4). Furthermore, forest stands are not only more efficient than annual crops for producing NPP, they are also towering by a more than ten-fold eco-volume/rain rate over the annual crops (Figure 5).

Eventually, the crop morphotypes/vegetation types with largest RUE (rain use efficiency) or WUE (water use efficiency) or NUE (nutrient use efficiency) on an eco-volume basis will take the lead in a particular environment. Hence, plants are not weight-watchers but space invaders.

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Urbanization Patterns and Consequences in Selected ASEAN Countries

Prof. Dr. Kyaw Lat

1. Introduction

ASEAN, the "Association of South East Asian Nations" was originally formed with 5 countries in 1967 but since 1996 the bloc was joined by 5 new member countries and since then the countries now try to reach the common goals and aims which include the acceleration of economic growth, social progress, cultural development among its members, the protection of the peace and stability of the region, and to provide opportunities for member countries to discuss differences peacefully [1] .The 10 ASEAN countries have a total population of around 560 million, or roughly 8% of the world's population, had a combined GDP of about U$ 896.5 billion in 2005 and the total GDP of the bloc is growing at an average rate of around 5.6% per annum.

All 10 countries are neighbours and situated in Southeast Asia, however there are large differences in terms of population, industrial output, political system and per capita GDP (Table 1). From demographic aspects, the states range from Brunei with 0.38 million to around 223 million population in Indonesia; from the aspects of urbanization, Singapore is home to 100% urban population compared to Cambodia with 20% of population in urban areas. The urbanization rate of the ASEAN countries is much higher than in other comparable regions of the world; between 2000 and 2005, the annual urban population growth rate of the region was 3.8%, whereas the rate of the whole Asia was 2.6% and of Africa was 3.3%. At present in 2007, the population living in the urban areas is about 44% and this ratio would change to around 62 % in 2020.

Table 1: Comparison of per Capita GDP and populations among the ASEAN Nations, extracted from Fact Book

	Countries in ASEAN	GDP per Capita in US$ in 2007 (Fact book)	2006 Population (mill.)	Area (sp.km)	Population density (persons / sq.km)
1	Brunei Darussalam	51000	0.4	5765.0	66.1
2	Singapore	49900	4.4	707.1	6489.3
3	Malaysia	14500	26.1	329876.0	84.1
4	Thailand	8000	63.4	513115.0	122.9
5	Indonesia	3600	228.9	1919440.0	119.2
6	Philippines	3200	86.3	300000.0	301.7
7	Viet Nam	2600	86.2	331690.0	259.6
8	Lao PDR	2000	5.8	236800.0	27.5
9	Myanmar	1900	48.4	676578.0	81.9
10	Cambodia	1900	14.2	181035.0	78.7

1.1 Terminologies of 'Urban Areas' and 'Cities'

The terms "urban" or "rural" is not consistent in the settlement planning literature; there is no internationally agreed definition of the term "urban". Various countries have different definitions; in general the definitions are normally decided on two factors, one is on the size of settlement (normally the population size), or function of a settlement recognized by that particular country as headquarter of an administrative area, in most cases as declared with government Gazettes. Taking Malaysia as an example, the gazetted areas with population of 10.000 and more are called urban areas; with Myanmar and Bangladesh, the definition is based on the administrative centre of an area: in the case of Myanmar, the headquarter of a township which may reach from a settlement with less than 500 population (Meisei in Kayah State) to over 300 000 in Mawlamyaing city, the third largest city in the country. In case of Bangladesh, a city is defined as the head quarter of an Upazilla.[2] Worldwide, there are different definitions nearly as much as we have countries in the world. When the international agencies like UNCHS or UNICEF work on country's profiles or statistics, it is the normal practice that they apply the definitions of respective governments, leading to large variations that cannot be exact but taken only as indicative data. In this paper the data on urbanization, urban growth rates, etc. have been frequently used, but the data is taken from various sources of UNICEF or other UN- organizations.

Similar to the term "urban", the word "city" is used in many languages, the exact definitions also differ from country to country. The followings are definitions in some countries found at hand: [3]

1. In the U.S., an incorporated municipality whose boundaries and powers of self-government are defined by a charter from the state in which it is located
2. In Canada, any of various large urban municipalities within a province
3. In Great Britain, a borough or town with a royal charter, usually a town that has been or is an episcopal see
4. In ancient Greece, a city-state

If the German word "Großstadt" should be taken as equivalent to the English word "City", the German definition according to Meyer's Lexicon is "a town with more than 100 000 population as defined by International Institute of Statistics in 1887", but it went on to say that in the medieval period a town was a settlement with more than 20 000 and in the 18th century the lower limit was 50 000. From all these we can conclude that the definition of this term "city" vary from country to country and also from time to time. In this paper, the word city is used just as a large town, have no definite limitation for population or size in term of area.

The 'law of the primate city' was first proposed by the geographen Mark Jefferson in 1939. He defines a primate city as being "at least twice as large as the next largest city and more than twice as significant.[4] This word "primate cities" has been in use since about 1950. For example, Laos has the total population of around 6 million in 2006, with the capital Vientiane which has together with metropolitan areas around 0. 5 million population and the second largest town is Savannakhet with 0.16 million, it is true that Vientiane has 3 times more population than Savannakhet, however Vientiane's environment is far away from cities to be called primate cities. It is a clean city and by car one can reach from end of the city to the other within 30 minutes. Thus, regarding the further definition of the primate cities as defined by Jefferson: "A primate city is the leading city in its country or region, disproportionately larger than any others in theurban hierarchy" [5], the question rises, how many times is disproportionately larger?

A mega city is usually defined as a metropolitan area with a total population in excess of 10 million people. Some definitions also set a minimum level for population density (at least 2,000 persons/square km). Megacities can be distinguished from global cities by their rapid growth, new forms of spatial density of population, formal and informal economics, as well as poverty, crime, and high levels of social fragmentation. A megacity can be a single metropolitan area or two or more metropolitan areas that converge upon one another. The terms conurbation and metroplex are also applied to the latter. The terms mega-polis and megalopolis are sometimes used synonymously with the word mega-city.[6]

1.2 Urbanization Patterns Compared

Today, half of the world's population lives in urban areas. In the coming decades, urbanization is expected to increase at an alarming rate especially in Asia and Africa. The global proportion of urban population rose dramatically from 13% (220 million) in 1900, to 49% (3.2 billion) in 2005 and it is projected that the figure is likely to rise to 60% (4.9 billion) by 2030.[7]

There are numerous studies on the reasons for the increasing rate of urbanization in Asia and Africa; the indicated reasons are mainly due to decreasing land/man-ratio in the rural areas which causes unemployment or underemployment leading to migration into urban areas. This process however has some positive effects such as accumulation of labour force in the urban areas which could be potential for industrial development if the countries have the policy to encourage the industrialization. De facto, the increase of urban population is not distributed evenly throughout the countries but concentrated only in some large cities and regions. Based on such backgrounds the focus should not only be on the rate of urbanization but also on the pattern of urbanization.

The population increase taking place mainly in the large urban areas resulting to development of primate cities and agglomeration areas has many negative effects. In most countries, the urbanization pattern is the formation of cities with the population with between 4 to 8 million accompanied in most cases with large, interdependent influence zones creating pollution to the environment as well as to the people living in these cities. The negative effects to the urban environment found with the primate cities can be summarized as:

- The air quality in many such cities and in their environs is below the respective quality standards; also, it is very difficult to improve the situation because a high percentage of pollution is emitted by the steadily growing numbers of vehicles.
- In case of the cities in the developing countries, the people or the migrants may be able to find jobs – but a large percentage of poor people living in such mega cities cannot find proper housing. Most of the people have to live in the congested squatters and in makeshift inhumane shelters in unhygienic conditions. The problems are not easy to solve, because the land and housing prices in such big cities are several times higher than in the smaller urban settlements and income of most migrant workers are low and unstable. Such low standard residential areas or squatters normally occupy the public owned areas where the land is not tightly controlled.
- Many people in such mega cities need many hours to commute to their places of employment. Because of the commuting time of several hours together with the working hours, many workers are away from their families for more than half of the working days, leading to psychological problems of loosening family ties.

- From the aspects of infrastructure and sanitation, the large portion of the population in most of such cities in ASEAN countries are not served with city water supply systems and most areas in these cities are not served with waste water systems.
- From the aspects of waste water and solid waste disposal systems, the amount of investment needed would be very high when the city authorities plan to install such systems.
- From the aspects of urban transportation, many cities in the poor countries cannot afford the expensive transportation systems like undergrounds or sky-trains and most of the urban poor have to use buses causing them longer travelling times and inconveniences.

For such reasons such megacities are considered negative in most urban planning literature. According to UN Habitat, the megacities of the future, (those with more than 10 million residents) will be "giant potential flood and disaster traps" if insufficient action is taken on behalf of their residents. [8]

1.3 Scope of research

It is not intended in this paper to point out the disadvantages of urbanization nor is the urbanization to be discouraged in the countries with large rural population. As mentioned above, it is accepted that the urbanization cannot be retarded and the urban areas also have advantages of providing employment facilities and they are efficient places for industrial production as well as for better health care and education services. The research aims at formulating alternatives that can bring healthier and more sustainable urban patterns and the ideas presented can be useful to the policy and decision makers in the respective countries. These alternatives would accept and encourage the urbanization on one hand and to channel to environmentally cleaner, healthier and more humane urban environments on the other. The objectives of the research work are:

1. To present and analyze the general urbanization trends in selected ASEAN countries
2. To present and analyze the impact of the present urbanization pattern in the respective countries
3. To point out other alternatives of urban development patterns

The cities of Southeast Asia have been evolving during the last decades because of demographic and socio-economic processes; also, the negative effects known today were not seen in the past decades. Moreover, this may be attributed partly to the lack of proper planning mechanisms. Thus, even as some countries achieved economic successes despite of negative urban environment, this was at the cost of human health and the environment.

This paper shall analyse the urbanization pattern in the countries of ASEAN-bloc and point out alternative urban patterns in cases where the changes are desirable or indicate the favourable alternatives to avoid the negative urbanization pattern or the patterns leading to deterioration of urban environment, but mainly based on environmental factors comparing examples and results of other countries that have gone through urbanization process in the last decades. Since this is not a regional planning project, the exact and detailed solutions for the future settlement pattern for the respective countries cannot be proposed within the framework of this paper, as this process would require much longer time, more manpower, comprehensive data and above all, the policies of the respective countries. It is however hoped that the points presented in this research paper will prove useful to the policy and decision makers in working out urbanization strategies in the countries concerned.

For the reasons presented mainly in variant definitions in chapter 1.2, the study on urbanization, on percentage of urban population, etc. in order to compare countries' situation, can only serve as indicative figures and there can be some variations. Based on these factors, the proposals on settlement pattern in this paper can only serve as indicative alternatives that need to be explored more in detail when elaborating further urbanization strategies.

2 Urbanization Patterns in the ASEAN countries

It has been mentioned that the urbanization process in ASEAN region is taking place with much higher rates than in Africa and in the whole of Asia. The character of this process or of the urbanization pattern among the 10 ASEAN countries however has some differences (Table 2, Figure 1). Among them the two countries Singapore with 100% urban population and Brunei with 74% already are almost totally or very highly urbanized, followed closely by Malaysia and the Philippines with 68% and 63% respectively. The other 6 countries still have a large percentage of rural population but all are urbanizing with very high rates. This may be a general and combined statement, but among these countries there are also vast differences in terms of country's population and urban growth rates or in terms of urban ranking systems and the sizes of the cities, etc. and therefore the analysis on the 10 ASEAN countries from the aspects of human settlement pattern and the observations, consequences and desirable urbanization patterns where it is necessary is presented in the following chapters of his research paper.

Table 2: Comparison of Populations, Urbanization and Population Growth Rates in ASEAN Countries (Source: Collected data from country-wise UNICEF at a Glance)

Country	Total Population in 2006 (mill.)	Total Population Growth Rate (1990-2006)	Percentage Urban in 2006	Urban Population in 2006 (mill.)	Urban Population Growth Rate (1990-2006)
Singapore	4.4	4.4	100.0	4.4	4.4
Brunei	0.38	2.5	74.0	0.28	3.2
Laos	5.76	2.2	21.0	1.2	4.1
Cambodia	14.20	2.4	20.0	2.8	3..5
Malaysia	26.11	2.3	68.0	17.8	4.3
Myanmar	48.37	1.2	31.0	15.0	2.6
Vietnam	86.21	1.7	27.0	23.3	3.4
Thailand	63.44	1.0	33.0	20.94	1.6
Philippines	86.3	2.1	63.0	54.3	3.8
Indonesia	228.9	1.4	49.0	112.1	4.4

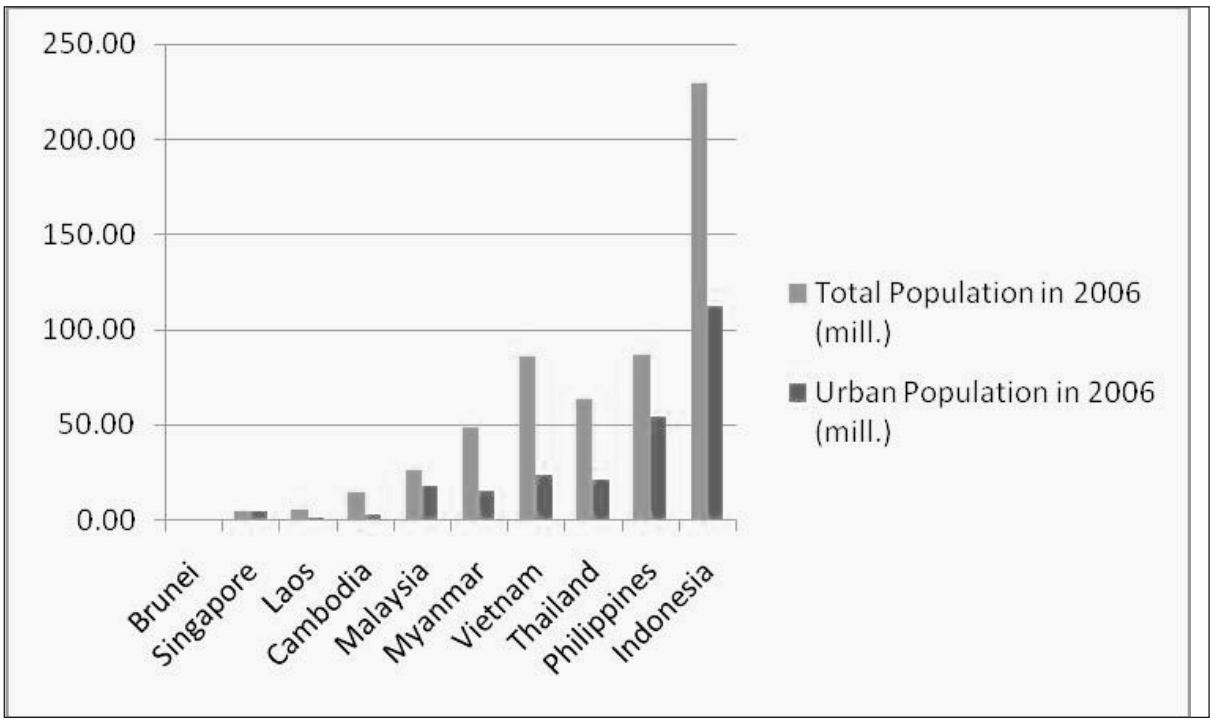

Figure 1: Population comparison among ASEAN nations

2.1 Myanmar

Myanmar has more population and higher urban population percentage than e.g. Cambodia and Laos (Figure 1); the city Yangon with about 4.5 million inhabitants is also truer to be called as a primate city. According to the UNICEF [9],the country's total population is 48 million in 2006, according to data attained informally from census department is 48.12 million in 1999 and that should be around 55 million in 2006[10] and according to World's Fact Book is 47.7 in 2008[11]. The data from UNICEF is more reliable and realistic because UNICEF's calculations are comprehensive and calculate based on the birth and death rates. The percentage of urban population as per UNICEF is 31% in 2006 and according to the data from the census department is 24.7 % in 1999. The country's total population growth rate between 1990 and 2006 is given by the UNICEF as 1.2 %, by World's Fact Book is as 0.8 %, whereas the figures from the census department would be 1.9% if calculated based on 35.5 million in 1983 and 48.12 million in 1999. The urban population growth rate given by UNICEF is 2.6% annually between 1990 and 2006, whereas calculated based on informal census figures would result to 1.98 %.

From the urban population of around 14 to 15 million, about 4.5 million or about 30% are in the city of Yangon and the second largest city Mandalay has about 1.5 million in 2006 if calculated based on the data from the census, but in reality it would be close to or more than 2 million, considering the population who are registered in the northern Kachin or Shan states but practically live in Mandalay. The other cities after Mandalay are Mawlamyaing with about 360 000, Bago with 230 000, Pathein with 220000, etc. and there are about 24 towns in the range of 100 000 and 400 000. The ranking pattern of urban settlements can be seen as: the city Yangon about 2 to 3 times more population than the second largest, Mandalay, which in turn is around 4 times more than the third, and the rest urban settlements are only slightly larger than the other.

This pattern is typical for development towards a single polar pattern in the future where the main city is disproportionately larger than the other urban settlements if there is no intervention or some other factors to change the direction.

2.1.1. The City of Yangon

The city of Yangon, on its way to become the primate city, brought negative effects to the city's environment, especially in the context of weak economies usually found in the developing world. The housing problems are the most important issue that most cities in the developing world face, but in case of Yangon this problem has been tackled effectively in the recent years with the Government's large scale housing solving schemes in the beginning of the 90s. The Government launched large scale site-and-service schemes, extended large urban centres and provided land to the people formally living in the squatters. Because of that large scale activities, housing or the squatter problems would not be serious for some years to come, but this is a problem that need to be tackled continuously and the housing schemes in the 90s also mean the problems are solved temporarily.

The other important issue is the water supply and sanitation. Together with city extension activities in the 1990s, there was a project for construction of new reservoir to get additional water sources for the city; the reservoir was completed in the 90s but it took some years for the city authorities until the new pipeline could reach the dwellers in the new suburbs and they were connected only after 2002. Other infrastructure provisions like electricity, waste disposal, etc. need to be improved continuously in big cities and the more the population, the higher are the cost and the more are the requirement of high level technologies.

The central waste water system exists only in the CBD area, which is also overloaded, where only about 7% of the population live and other areas have to solve the problems with septic tanks and in the newly extended low income areas mainly with the pit latrines. The similar situation are found in other branches such as electric supply, on which it can generally be said "insufficient", in some areas being served only some hours of a day. Concerning the air quality, people in Yangon are lucky at least at present, the quality is good because of the low density, many green areas and less polluting sources. It is obvious that such problems like air pollution, traffic jams, etc. would accompany with the country's technical development and the increased industrialization and economic activities would change the situation rapidly. The best way is to plan ahead and steer for the favourable urbanization pattern and avoid unbalanced development of primate cities.

2.1.2. The Projection for future Urbanization Patterns

As mentioned above the urbanization pattern is typical for development towards a single polar pattern in the future where the main city is disproportionately larger than the other urban settlements if there is no intervention or some other factors to change the direction. There are some favourable factors that would prevent one sided development of Yangon to become disproportionately larger than Mandalay. One obvious point is that Mandalay has higher growth rates between 1983 and 2004 and other reasons hampering such development are:

- Mandalay as the former Kingdom's Capital, is located at the geographic centre of the country, which has a high growth potential being at the central location of the country.
- The city is on all main lines of communication (railways, highways, Ayeyarwaddy River and also having an international airport). All these transportation facilities join directly the southern Myanmar areas, northern areas like Shan State, Kachin State, and Chin State.
- The city is on the trade route to China's Yunnan province and to India's Assam and Manipur states
- Additionally the Government constructed a new international air port, functioning since 2000.

- Additionally the Government has developed some industrial areas around Mandalay and around Sagaing, another town in a neighbouring administrative division, but practically just one town because of its proximity to Mandalay, the city is about 50 km away or an hour drive from Mandalay.

Concerning the urban-rural population projection, the 31% of urban population or close to 15 million in 2006 shall grow to 21.5 million in 2020 and close to 28 million in 2030. To project the expected population of the future, Yangon seems to have a lower growth rate of around 2.7% and Mandalay has higher growth rate of 3.5%. Calculated based on these figures, Yangon shall grow from 4.5 in 2006 to around 8.5 million in 2030, and Mandalay from around 1.7 to around 3.9 million in the same period, meaning that the traditional ratio of about 1:3 would reduce to around 1:2, a much better figure and desirable if that ratio can be less.

This situation of disproportionate city sizes is recognized by the concerned authorities as well as Mandalay city authorities and therefore since about the year 2000 there were plans that the city's area should be extended by integrating the neighbouring settlements and providing urban facilities with the improvement in water and power supply and to have the population of about 2 million by 2006. From the side of central authorities the move in line with this idea is to have constructed Mandalay International Airport. This plan obviously cannot be followed consistently probably due to economic problems after 2002 which require high capital requirement for infrastructure extension. It would be the best for Mandalay as well as for the country if this idea can be followed firmly and endeavour the country's urbanization pattern to become "bipolar".

Another action, moving the Government's administrative headquarters to Nay Pyi Daw, another newly developed town near Pyinmanar, must also be seen as positive from the aspects of reducing Yangon's role as a primate city. This shall change Yangon's role as a place with overlapped multiple functions; until now Yangon has been the commercial, administrative, and cultural centre of the country, which has the biggest potential to grow to a large urban agglomeration region with pollution, traffic jams, and infrastructure congestion problems.

This action of moving the country's administrative centre shall reduce the role of Yangon, but cannot be expected as the country's urban pattern to become "tri-polar". Based on examples of counties which changed their administrative headquarters, it can take some 5 decades until the new capital becomes really functional, commercially as well as culturally as the capital city. The best example should be taken Brasilia of Brazil which was originally planned in 1960 as a city for 500.000 population, and it took around 40 years to become a real competitive city with about 2 million population at present [12].

In addition to developing Mandalay as the second pole, it is advantageous to have secondary towns with the population between 500 000 and 1 million, and these should be for small scale and medium size industries. These should also have the function as buffer zones for the main

polar cities and to absorb the immediate migration from the rural areas. The country's population density is thin compared to neighbouring countries and therefore the transportation network density is also low and the secondary towns should be located at the areas where the communication lines meet and where the population growth rates are high. The shape of the country is elongated, broader in the middle and narrow at the southern and northern areas and the population density is higher in the middle portion along the Ayeyarwaddy river basin. To identify these secondary urban centres, all towns having population more than 150.000 and annual growth rates more than the natural population growth rates are sieved out and selected as the potential secondary towns for future growth. Altogether 11 towns fit into these criteria (table 3), and from these, the 4 towns Bago, Pathein, Sitwe and Mawlamying are the capitals of states and divisions and therefore these towns must be seen as secondary towns. Since there are 14 states and divisions, another 10 towns which are the capitals and, additionally, Nay Pyi Daw, the newly developed administrative headquarters, result to 22 urban centres altogether are defined as potential towns for development as the secondary towns (Table 4). These should be at the second rank after the 2 main poles of Yangon and Mandalay (Table 5).

Table 3: Myanmar, Capitals of States and Divisions

Sr. No.	Townships	States/ Division	1983 (Census)	1999	2000	2004	GR 83-04
			Urban	Urban	Urban	Urban	
1	Haka*	Chin	12670	19344		24039	3.10
2	Loikaw*	Kayah	35498	54197	69889	80428	3.97
3	Pa An*	Kayin	69337	105862		82329	0.82
4	Magwe*	Magwe	54881	83791		106076	3.19
5	Dawe*	Taninthayi	69882	106694	123752	136760	3.25
6	Myitkyina*	Kachin	62223	55477	126215	139444	3.92
7	Sittwe*	Rakhine	107621	164313	187879	205835	3.14
8	Pathein*	Ayeyawaddy	144096	137513	217913	234875	2.35
9	Bago*	Bago	150528	229822	241036	261425	2.66
10	Taunggyi*	Shan	130238	198844	114480	265360	3.45
11	Mawlamyaing*	Mon	219961	308432	354954	392190	2.79
12	Sagaing*	Sagaing	46584	71123	82757	92768	3.33

Table 4: Urban Centre with more than 150 000 Population and High Growth Rates

Sr. No.	Townships	States/ Division	1983 (Census)	1999	2000	2004	GR 83-04
			Urban	Urban	Urban	Urban	
1	Lashio	Shan	107036	117111	141465	165734	2.10
2	Myeik East	Taninthayi	88600	135272	156884	173376	3.25
3	Pyay	Bago	83332	127229	156461	169618	3.44
4	Monywa	Sagaing	107704	164439	218068	244456	3.98
5	Meiktila	Mandalay	96496	147327	199344	226718	4.15
6	Myingyan	Mandalay	77060	70946	159195	181578	4.17
7	Hinthada	Ayeyawaddy	82005	125203	142299	153374	3.03

Table 5: Two Major Poles and the New Administrative Centre

Sr. No.	Townships	States/ Division	1983 (Census)	1999	2000	2004	GR 83-04
			Urban	Urban	Urban	Urban	
	Mandalay	Mandalay	532949	813691	801707	1200000	3.51
	Total YCDC	Yangon	2472176	3795315	3898373	4339358	2.72
	Nay Pyi Daw	Mandalay	52962	47207	109410	124435	2.79

2.2 Vietnam

Vietnam's urbanization pattern is much more favourable in terms of population distribution and also the position of urban centres in the transportation network compared to the situation in Myanmar. In addition to the favourable structure of urban fabrics, there is also better intervention from the government's planning system with the "5 Economic Regions". The most advantageous situation in Vietnam is to have two large urban growth centres because of historic reasons, one located in the southern part and other in the northern part of the country, both at the central places.

Table 6: Population projection for Vietnam

	Year 2006	% to total population (2006)	Year 2020	% to total population (2020)	Year 2030	% to total population (2030)
Total Population (mill.)	86.21	100.00	109.15		152.31	100.00
Urban Population (mill)	23.28	27.00	37.17	34.05	82.24	53.99
Ho Chi Minh City Population (mill.)	7.90	9.16	10.30	9.44	12.68	8.32
Hanoi City Population (mill.)	3.40	3.94	8.65	7.92	10.71	7.03
The rest urban (mill.)	11.98	13.89	18.22	16.69	58.85	38.64

Calculated based on
Total population growth rate is 1.7 % as adopted by UNICEF
Percentage of urban population is 27% in 2006 as adopted by UNICEF
Urban population growth rate is 3.4 % as adopted by UNICEF
Ho Chi Minh City's growth rate is2.1% as adopted by master plan
Hanoi growth rate is based on 2.16 % as adopted by master plan

According to UNICEF's statistics, the country's total population is 86.21 million in 2006 with 23.3 % urban population (Table 6) [13].The urban population growth rate between 1970 until 1990 was calculated by UNICEF as 2.7% annually and between 1990 and 2006 was 3.4%; a realistic estimate indicating that country's urbanization rate is increasing due to economic growth. Based on that growth rate of 3.4%, the urban population shall double in every 20 years and assuming this rate should persist in future, Vietnam shall have 54% of the total population living in urban areas in 2030.

2.2.1 Hanoi and Ho Chi Minh City

Compared to the structure of having one very large urban centre, which normally leads to environmental problems, it is an advantage to have two or more urban poles. Vietnam has Ho Chi Minh city with 7.9 million population and Hanoi with about 3.4 million in 2006 (table 6). For the time being the sizes are roughly one about two times larger than the other, but it seems

that the authorities have the policy to change this ratio gradually. According to the master plans of the two cities, they would be about the same size with 12.7 and 10.7 respectively in 2030 [14, 15]. Also positive is that the urban population increase in future should not only be concentrated in these two polar cities but there are plans to have ranks of urban sizes and to be distributed also in other towns which are connected to the country's economic plans. In 2006 the combined population of the two cities Hanoi and Ho Chi Minh City is 11.3 million or around 48 % of the total urban population, which should change to 28.5 % in 2030. That means that there will be around 58.96 million urban population increases from 2006 until 2030, out of which 12.1 or around 20% should be absorbed in the two cities (Figure 2).

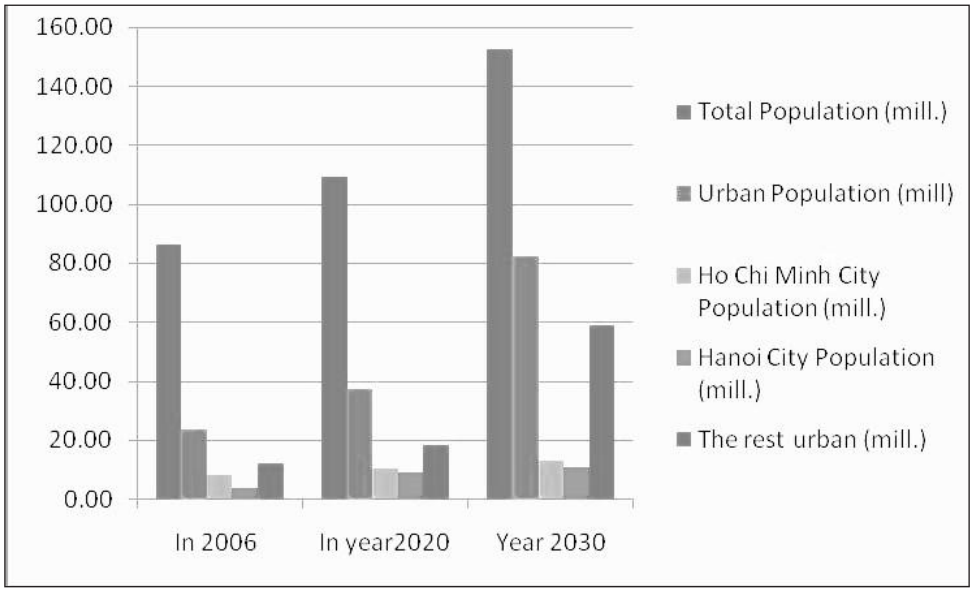

Figure 2: Vietnam, population projection for country, the two main cities and other urban

As mentioned, the large cities always have many environmental problems; out of these, housing, urban sanitation, air pollution and the urban transportation are the most serious. There are studies that Ho Chi Minh City, being a city with nearly 8 million is already facing such problems. The main sources of air and noise pollution are due to a large percentage of people owning motor bikes used for commuting to work. It was reported that every two persons own one motor bike in Ho Chi Minh City and that is the main reason for the city to have high dust and benzene levels with intersections of the city exceeding permitted standards by 100 to 200% [16].The reason for the high percentage of people using motor bikes is mainly because the public transportation has not been improved in line with the population increase in the last decades. This problem however is obviously recognised by the authorities, and the urban railways are planned in both cities to alleviate the transportation problems. It is envisaged that after the completion of urban railway systems, a large percentage of commuters would change to urban rails and reduce one

of the sources for air pollution in the city [17].This must be seen as an action taken in advance to solve the future problems. Quite normally, a city like Ho Chi Minh City with around 8 million population and about 2000 sq. km would need an effective urban railway system. The same thing goes also for Hanoi transport system which should serve 6,000 passengers per hour in the first phase, 9,000 in 2020 and 12,000 in 2030 [18].

It seems that the authorities are well aware of preventing one city growing very fast and becomes a single-pole primate city and therefore there are plans for two cities acting as balancing poles to each other. Also concerning the serious environmental problems arising from traffic jams is known to the planners of the cities and expressways and urban rail systems are presently under construction in both cities.

2.2.2 Population Growth in other Urban Centres

Another issue is the planning and development of secondary urban centres to absorb the urban population increase until 2030. The magnitude of that population to be absorbed in urban areas outside the two major cities can be estimated at around 47 million. The best location of these urban centres is obviously along the main north-south A1 highway also on the alignment with the Asian highway leading to China. From the Government's planning of "5 economic regions", the desired urbanization pattern can be interpreted. It seems that the pattern the authorities have in mind is the development of another three urban regions to take over the role of the next urban rank size. In line with the plan of economic regions, the 3 cities selected as the second rank urban centres are Haiphong, Da Nang and Bien Hua.

Hai Phong has existed as a significant port city since several centuries, and was one of Vietnam's principal trading centres, approximately 100 kilometres from Hanoi. Today, it serves the entire northern region of Vietnam and has large economic growth rates exceeding 12% per annum over the last decades. Haiphong has 7 urban districts with about 700,000 population and about 1 million in the 8 suburban districts, totaling about 1.7 million in 2006. Being a port city and its closeness to Hanoi the city has high potential for growth and earns to take the role of an urban centre in the second line [19].

Another city which has about the same potential for growth is Da Nang, which is also the port city for the South Central Coast of Vietnam and the fourth most populous city of Vietnam. In terms of population and in terms of the position, the city has similar characteristics as Haiphong, about the same size of urban population, about 800,000 in 2006 and is expected to grow to 968,000 in 2010 and 1,415,000 in 2020, that is with the average growth rate of 4.1 %. Also from the aspects of economic growth, the city is similar to Haiphong; the economy is growing at around 13% per annum in 2006, the highest growth rate in Vietnam [20].

Biên Hòa is a city in Dong Nai Province but practically considered as a part of Ho Chi Minh City since it is only 30 kilometers east of Ho Chi Minh City, to which Bien Hoa is linked by Vietnam Highway 1. Now the city has an estimated population of over 550,000, and also an industrial center of southern Vietnam, and many factories and warehouses, many of them invested by multinational companies operate in the area surrounding the city [21] .

2.3 Thailand

Thailand is a country which had made a vast economic progress in the last 40 years. From the aspects of settlement and urbanization pattern, there are many steps to work towards environmentally friendly and humane pattern especially in the capital region known as Krung Thep Maha Nakhon. This is a region with concentration of population and economic activities and any other region in the country cannot be a match for BMR or Bangkok Metropolitan Region. From the aspects of economic development, Thailand is one of the very few countries in Asia and Africa that had attained the position to change from being an agricultural nation to the level of joining the rank of the newly-industrialized countries (NICs). The position of Thailand's export products in the world market is: [22]

1. The world's number one exporter of rice, rubber, chilled fish and prawns,
2. The world's largest exporter of canned products,
3. The world's second largest exporter of sugar and tapioca products,
4. The world's fourth largest exporter of frozen chicken, maize and cut flowers.
5. The world's largest exporter of precious stones,
6. The world's third largest exporter of hard disks and integrated circuits.

It is seen from the above export items that Thailand's economic development does not rely only on the natural resources; all the raw materials needed for export of these items must be grown, or imported and processed. In terms of per capita GDP, Thailand has around 8000 US$, which is at the third position among the 10 ASEAN countries, next to Singapore, Brunei and Malaysia [23].

2.3.1 Bangkok's primacy role

These achievements in economy however are mainly performed in one agglomeration area with about 11 million population known as Krung Thep Maha Nakhon or the Bangkok Metropolitan Area, in short BMA. The city of Bangkok itself has about 8.9 million and BMA has about 11 million in 2007 [24]. BMR with around 6 provinces has a total area of about 7761 sq.km. is only 1.5 % of country's total area but the share of this region to national GDP is about 40 % and the per capita income of the metropolitan area of Bangkok was about four times as much as the national average in 1995 [25]. This situation indicates the role of the capital area and the continu-

ing regional divergence within the rest of the country (Table 7). The area with about 11 million population causes several problems to the urban environment as well as to the population living in this area. This huge urban agglomeration area was not intentionally planned from the beginning, but gradually grew since the 1960s and this is not a good example to follow for other nations in the neighbouring countries which are not yet urbanized and developed to this extent.

Table 7: Population projection for Thailand

	Year 2006	% to total population (2006)	Year2020	% to total population (2020)	Year 2030	% to total population (2030)
Total Population (mill.)	63.44	100.00	72.93	100.00	80.56	100.00
Urban Population (mill)	20.94	33.00	26.15	35.85	30.64	38.04
Bangkok BMR Population (mill.)	8.90	14.03	10.37	14.22	11.57	14.37
The rest urban (mill.)	12.04	18.97	15.77	21.63	19.07	23.68

Calculated based on
Total population growth rate is 1.0 % as adopted by UNICEF
Percentage of urban population is 33% in 2006 as adopted by UNICEF
Urban population growth rate is taken as 1.6 % as adopted by UNICEF between 1990-2006
BMA‘s population is expected to grow with 1.1 % between 2000 and 2010
According „Emerging world of Cities“
Therefore BMA‘s growth is taken as 1.1 % up to 2030

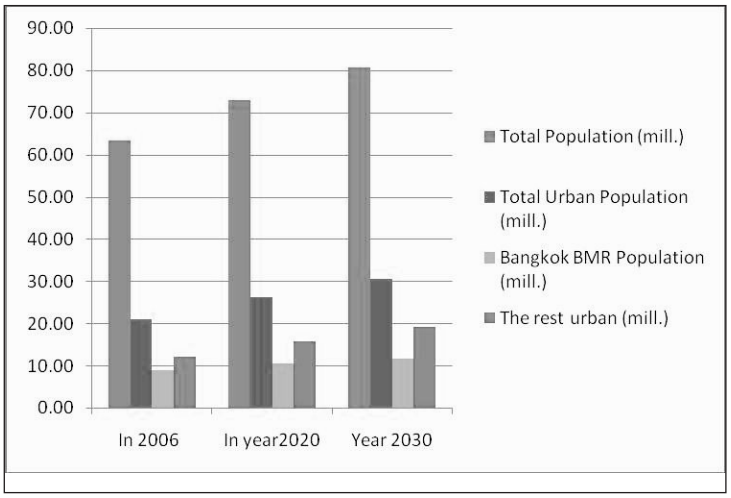

Figure 3: Thailand, population projection for country, BMR and the rest urban

Based on data from UNICEF, Thailand has population of 63.44 million and the percentage urban is 33% in 2006, meaning 20.94 million population live in municipalities which are defined as urban. The urban population growth rate between 1990 and 2006 is given by UNICEF at 1.6% [26] . The population of the BMA was calculated to grow at about 1.5% per annum between 1990 and 2000, and 1.1% between 2000 and 2010. Based on these figures the percentage of urban population would change from around 21% in 2006 to 38% in 2030 [27]. Calculated based on these data, the total urban population growth rate is 1.6%, growth rate of BMA is 1.1%, population, BMA's present portion of close to 40% to the total urban population would reduce slightly to around 38 % in the year 2030 (Figure 3). That implies that there is no visible sign that the population-wise supremacy role of BMA would significantly change in the future. The concentration of population, industries and other activities normally lead to urban environmental problems.

2.3.2 Air Pollution in Bangkok

Like many other large cities, Bangkok faces pollution problems and traffic congestion. Major source of air pollution in most cities are the industries and the vehicles; in the case of Bangkok, there should be around 2.6 million vehicles in 2001 driving round daily are identified as the main sources of air pollution, and it was mentioned that the vehicle stock was increasing by 481 cars every day [28]. According to studies, vehicles accounted in Bangkok for an estimated 80% of NOx emissions, 75% of carbon monoxide emissions, 54% of PM emissions, and nearly 100% of hydrocarbon emissions in 1999 [29].

Since in the recent years, there have been some efforts from the part of city authorities to improve the air quality and there should have been a decrease in the amount of harmful small dust particles since 1997 by 47 percent, from 81 to 43 micrograms per cubic meter. Bangkok's air, on the average now falls within the limit set by the U.S. Environmental Protection Agency of 50 micrograms per cubic meter, but is above the European Union limit of 40 [30].Despite these positive achievements some other studies found out that this improvement in air quality is not evenly distributed throughout the city, and some other studies point out that only 7 of BMA's 60 green roads have safe air. Probes found that Sukhumvit is the most polluted road that has over 300 micrograms per cubic meter (mpcm) far above the standard of 120 mpcm [31] . It is obvious that in Bangkok and in many other cities with similar characters, the air pollution cannot be maintained in the long run because of the increasing traffic. The air quality improvements in a short period are mainly due to the introduction of strict regulations on vehicle emission control. The traffic on the other hand is and has been increasing continuously and it should be in the range of around 3.8 million by 2008 [32].

2.3.3 Urban Transportation, Traffic Jams and Commuting Time

Because of the large city area, traffic congestion and high urban densities, the commuting time in the city of Bangkok is notoriously long. It was reported that Thailand has the longest commuting time in the world; the average working person living in Thailand spends 2 hours every day travelling to and from work, where the world's average should be 80 minutes altogether to and from work [33]. The usage of individual cars is interdependent to the level of public transportation systems. Because of the inefficiency of public transportation, the people tend to use more individual cars which contribute again more to air pollution and to traffic congestion. Bangkok is also known for slow driving speeds, the studies say the average driving speed is 8 to 9 km per hour and 2 to 3 km in rush hours [34] and Bangkok drivers spend the equivalent of 22 days/year in their vehicles [35]. The slow moving vehicles and traffic congestion contribute again to the air pollution, and this issue is now well recognised by the city authorities, and since about 2 decades there have been new construction and improvements in this sector by building sky-trains and underground rails, expensive solutions and possible to implement only with high capital costs.

2.3.4 The Urbanization Pattern, Issues of Inequality and Alternatives

The results of some studies on primate city's environmental situation as presented above are mainly the tangible factors such as air pollution; long commuting time and traffic congestion, but there are also factors that disciplines like urban sociology and psychology need to get involved. These are for examples psychological and sociological effects of the families from long commuting time. Although statistical data and studies on these problems are not readily available, it is known that the bred earners of the families are away from the family for more than 12 hours daily which could lead to loosing family ties and cohesion which can also affect the upbringing of children.

In this paper it suffices to mention that the concentration of industries, population and other economic activities bring negative effects to the urban environment and in the long run can also affect the national unity. There are also some studies on the inequality in income distribution, indicating that inequality measures in Thailand vary considerably by region. NESDB (National Economic and Social Development Board) found that in the Gini index was lower in rural than urban areas, and lower in the South and the North than in other regions of the country, one study cited in NESDB reported a much lower Gini in Bangkok and surrounding areas than in other parts of the country, with the highest Gini found in the South.[36]

In addition to the problems presented, there are sewage problems, drainage problems and other urban sanitation problems not mentioned here, but Bangkok faces all these problems. Out of many urban infrastructures, sewage and urban mass transportation problems like underground

and sky-train systems require enormously high capital and also proper legal framework to implement the projects which are not always in existence in most developing nations. Legal framework is the first necessity because in many cases some private land must be taken away for infrastructure installation in the interest of the public.

These problems, may they be air pollution, long commuting time, urban sanitation, etc. can only be solved with the systematic approaches with regional and urban planning. Isolated city planning only with the view to solve city problems shall not achieve affective results. All environmental problems are interconnected; industries and economic activities attract people, there is traffic because of industries, economic activities and population attract traffic, traffic and industries create pollution, the traffic jams, long commuting time, etc. Without reducing the concentration of economic activities and without changing the land-use pattern with diversification and reducing urban concentrations there shall be traffic, industries and air pollution. In short; the best way is to keep the city population in the manageable size.

3 Résumé and Summary of Findings and Recommendations

The urbanization rate of the ASEAN countries is much higher than in other comparable regions of the world; between 2000 and 2005, the annual urban population growth rate of the region was 3.8%, whereas the rate of the whole Asia was 2.6 and of Africa was 3.3. At present in 2007, the population living in the urban areas is about 44% and this ratio would change to around 62 % in 2020. Based on the findings of this paper human settlement pattern of the countries in the ASEAN nations expressed in short as follows:

- **Myanmar:** Yangon has been a primate city until recently, but there are plans to diversify by developing Mandalay and shifting of the country's administrative centre. The higher growth of Mandalay compared with Yangon has been identified and with that rate Mandalay can become a second pole and there are also endeavours that the growth of Mandalay should be encouraged. With that the country can become a bipolar urbanization pattern with secondary towns.

- **Vietnam:** Vietnam has favourable settlement pattern because of having two urban poles. The government has well defined and well planned rank size urban pattern, Ho Chi Minh City and Hanoi in the first rank and the three others in the next line and with good plans to tackle the future problems.

- **Thailand:** The country has 33% urban population in 2006, the urban growth rate is low with 1.7% and therefore the percentage urban shall change slightly to 38% in 2030. Bangkok region's role as the single-polar urban agglomeration shall continue, the present urban environment shall continue to deteriorate if there is no effective planning intervention.

- **Laos:** The percentage of urban population is still around 20%, but urbanizing with high rate. If it is envisaged that Vientiane should have one million population in 2020 and 1.8 million in 2030, systems like waste water systems, rails for urban transportation should be planned in advance at least on paper and promulgate necessary legal framework and reserve the land areas for installation of sewers, drainages and urban railway lines. In addition to planning Vientiane, preparing other towns to absorb future urban population is equally important. Luang Prabang in the north and Savannakhet in the south should be focussed as potential cities with growth.
- **Cambodia:** The percentage of urban population is also still around 20%, about to be urbanizing with high rate, but in the direction of having one single polar pattern if there is no planning invention. Sihanoukville, Battambang, Poipel at the Thai border and Stung Treng in the northeast region should be focussed as urban centres in the second rank. Cambodia is naturally provided by river systems that are used as communication lines, and the alignment of the newly constructed Asian Highways shall support the growth of the towns on the lines of communication.
- **Malaysia:** Malaysia's urban growth rates with 4.3% annually between 1990 and 2006 are one of the highest in the world. With the present rates the country shall be up to 89% urbanized in 2020. Because of good planning and development of parallel regions for the industries and other economic activities in Johor Bahru and Penang, there is no danger for disproportionate urban development. However Kuala Lumpur as the primate city shall have close to 3 million after the second decade of the 21st century and there have been studies about K.L.'s air quality due to high vehicle usage. The city is in the position to plan ahead and install modern infrastructure.
- **Philippines:** The country is already highly urbanized with 63% urban population. The National Capital Region or Metro Manila shall continue to develop as the primate city. If there is no intervention the region shall have 25 million in 2030 and the present urban environment shall continue to deteriorate. It would be the best if the cities in the second rank, Luzon, and Davao can grow to about 3 million population each, with that the growth of Manila region can be balanced out with other two urban centres.
- **Indonesia:** There are 2 issues; one is the population concentration in Java Island and the other is the agglomeration of population and economic activities in Jabotabek region. Jakarta city's population is close to 9 million and Jabotabek region also has to 23.6 million in 2006. It involves very high capital and large amount of tasks to tackle the urban problems on that magnitude. The city and its region shall continue to grow but the best way is to develop another urban centre to balance the Jabotabek region and that region should be away from the present capital region. With this solution the growth of the capital region can somehow be retarded.

- **Singapore and Brunei:** Relatively less population compared to other nations of ASEAN, also area-wise small, highly or totally urbanized.

The main causes for the deterioration of urban environment can be summarized as follows:

- The cities grow because of economic advantages
- The cities grow without proper planning due to lack of planning intervention and planning mechanisms
- Many city dwellers belong to low income people and cannot afford proper housing and slums and squatters emerge
- The growth of cities continue without proper infrastructure and because the installation of proper infrastructure is expensive
- The city's concentration of population, industries, vehicles and other economic activities deteriorate urban environment

These urban environmental problems presented in this paper, may they be housing and squatters, may they be air pollution, traffic and long commuting time, urban sanitation, etc. can only be solved with the systematic approaches with regional and urban planning. Isolated city planning alone with the view to solve city problems shall not achieve affective results.

All environmental problems are interconnected; industries and economic activities attract people, there is traffic because of industries, economic activities and population attract traffic, traffic and industries create pollution, the traffic jams, long commuting time, etc. Without reducing the concentration of economic activities and without changing the land-use pattern with diversification and reducing urban concentrations there shall be traffic, industries and air pollution.

The best way is to keep the city in the manageable size. Therefore, discourage the growth of mega cities with planning intervention, with diversification, to create more than one urban pole and to develop secondary urban centres.

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Trends in Biomass Based and Alternative Fuels for Transport

Horst E. Friedrich, Simone I. Ehrenberger, Stephan A. Schmid

1 Introduction

From a historical point of view, using agricultural products for fuelling is a well-known objective among automobile engineers, but never became really accepted. For some alternative fuels such as compressed natural gas (CNG) and liquified petroleum gas (LPG) in Europe, niche markets could be established due to tax exemptions and the objective to open new markets for CNG and LPG. Additionally, the governments have wished to lower dependencies on fossil oil products at least since 1973, the year of the first oil crisis.

In the past years, motivations of political and economic actors for searching alternatives to fossil fuels have changed. Reduction of greenhouse gas emissions in order to mitigate climate change is on the top of the politic agenda. Recent reports by the Intergovernmental Panel of Climate Change (IPCC) have confirmed previous judgements on physical mechanisms and future impacts. "Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change…" [1].

Total world CO_2 emissions due to transport were approximately 5.8 Gt/a in 2005 and will rise to 8.4 Gt/a in 2025, and 12.3 Gt/a in 2050 according to projections by IEA [2]. This means, roughly one fourth of total CO_2 emissions are due to transport, in Europe 23 %, in Germany 12 % alone due to passenger cars.

Biofuels and alternative fuels provide a way to lower greenhouse gas emissions. However it is still discussed amongst scientists as well as in politics and industry, which fuels, feedstock and conversion technology might be best and to which extent it can reasonably be used. In the following, we aim to give a broad overview on the status and relevant issues of discussion on biofuels and alternative fuels.

2 Status of Production and Consumption of Alternative Fuels

Recent discussions about fuel supply and possible alternatives to the conventional fuels gasoline and diesel are dominated by the questions of how to establish a biofuel market and how to push the development of new renewable fuels being more energy efficient and versatile than the so called first generation, which includes bioethanol, biodiesel, biogas, biomethanol and vegetable oil. As the latter is only used in niche markets mainly in Germany and is not considered to be seminal, the present world market of biofuels is restricted to bioethanol, biodiesel and - to a significantly lower extent – biogas and biomethanol. But production paths of fuels from biomass vary significantly, depending on the type of feedstock and the processing technology (Figure 1). Today's most important production paths are the esterification of plant oils for biodiesel and the fermentation of sugar for bioethanol.

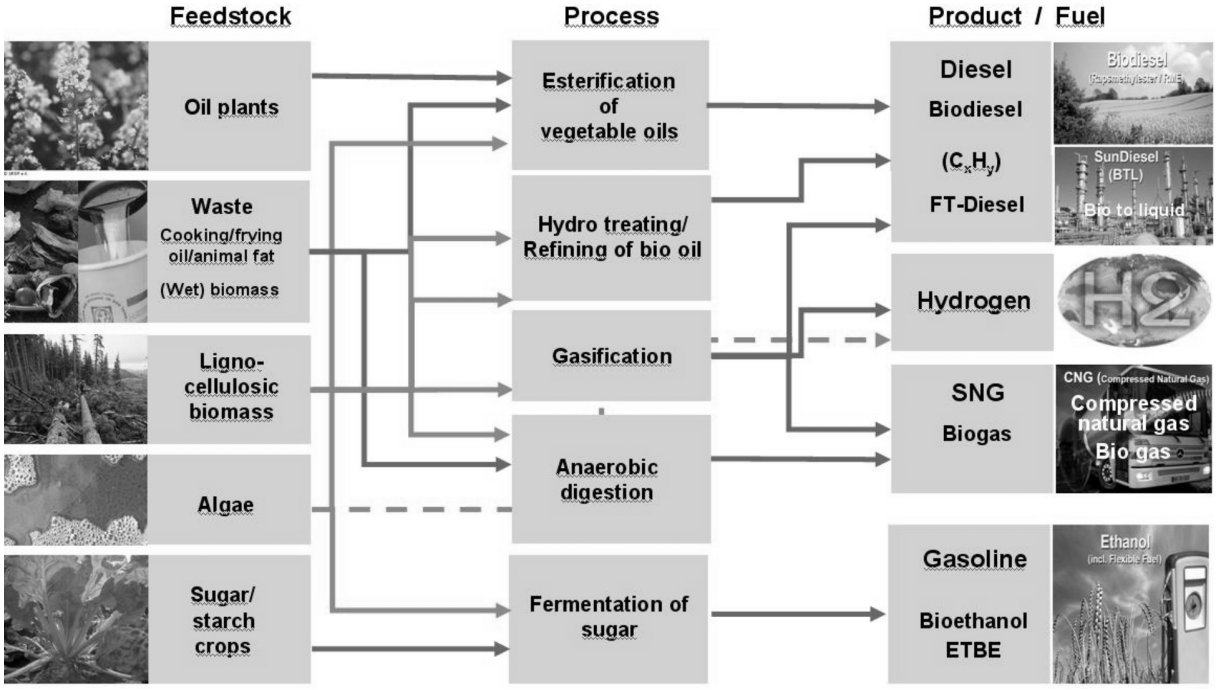

Figure 1: Conversion routes for biofuels

Liquid and to a lower extend also gaseous biofuels can be used in present combustions engines. This is a major advantage compared to other alternative fuels like hydrogen or electricity. Many countries worldwide have implemented research programs, incentive systems and quota regulation to support fuels made from biomass. In the EU, for instance, a given target is a 5.75 % market share by energy content in 2010. Though it is technically possible to adapt today's vehicle to work with neat biofuels, this share will be reached mainly by blending conventional fossil fuels with biodiesel or bioethanol. Mostly liquid biofuels are added to gasoline or diesel in low proportions. The EU norm allows a 5 vol.-% rate ethanol for gasoline (EN 228) and biodiesel (EN 590) as additive to conventional diesel. Since European policies have been sup-

porting the implementation of a European biofuel market, the production and consumption of such renewable fuels are increasing steadily. In 2006, the production of liquid biofuels reached 6,136,000 t or 5,002,000 tons oil equivalents (toe) [3].

Generally, an efficient use of plants for non-nutritional issues requires certain climatic conditions that allow high biomass productivity. Thus, subtropical and tropical countries would be able to produce considerable amounts of biofuels at significantly lower prices compared to Europe, for example. Apart from Brazil, which has been supporting the use of bioethanol for transport for more than 30 years, South Asian countries have started biofuel programs in the past years. Thailand, for instance, plans to increase its ethanol content in petrol to 20 % and its biodiesel blend to 5 %, in order to cut the overall consumption of fossil fuels by 20 % until 2030 [4]. Thus, the country boosts the planting of cassava, jatropha and palm oil intensively. India is another country with further potential in biofuel production. It has been the world's largest producer of sugar in 2007 / 2008. Due to sugar oversupplies, the Indian government adopted mandatory targets for use of ethanol of 5 % blend to gasoline from October 2007 and 10 % in 2008.

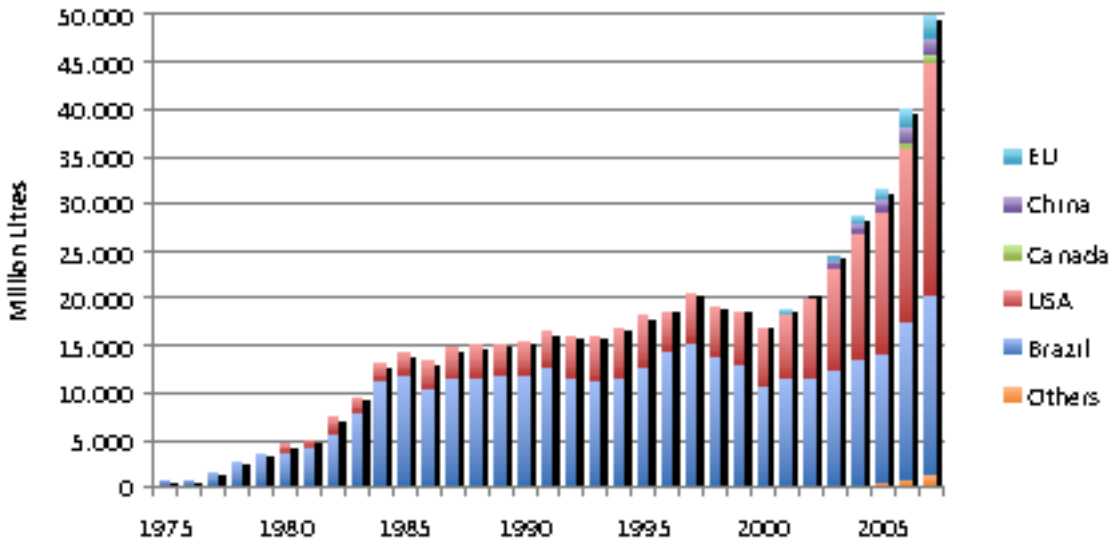

Figure 2: Development of bioethanol production worldwide [5]

The worldwide biofuel market is dominated by the production and the consumption of bioethanol, mainly extracted from sugar cane and maize. The EU is an exception as biodiesel represents almost 80 % of the liquid biofuels produced there (year 2006). Overall production of bioethanol amounted to 49.7 bln litres in 2007 (Figure 2). Leading country for many years has been Brazil where most of the ethanol is produced from sugar cane. But in 2007 the USA overtook Brazil with 24.6 bln litres of ethanol, which is mainly made of maize.

Considering the consumption of biofuels, the situation is similar. In terms of ethanol share of the fuel demand Brazil has by far the highest percentage worldwide (48 % ethanol of gasoline and ethanol use) [6]. 2,2 million cars fitted with flex fuel engines have been sold in 2008, representing 93 % of the car sales [7]. Considering the absolute amount of bioethanol used, the US market is market leader due to its high overall fuel consumption.

Recently, the use of biofuels has been criticized due to the land use competition between feedstock for food production and crops for biofuels. Thus, in the mid term future, so called second generation biofuels, are supposed to be a main pillar of the alternative fuel supply. One attempt is the production of non-conventional bioethanol. This includes the use of lignocellulosic material, castor oil seed cake or sugar cane bagasse for bioethanol production. For the bagasse production path, a demonstration plant is planned in Brazil for 2010 [8].

Another present research topic is the use of algae as feedstock. Algae show the advantage of being able to grow under climatic and environmental conditions that are not suitable for common crops. Certain species show hectare yields greater than those of tropical plants [6]. Since primary nutrients for algae growth are CO_2 and NO_x, fabric gases, for example, could also feed them. Depending on the species, algae can be used for bioethanol, biodiesel or hydrogen production.

Advanced fuels also include liquid synthetic biofuels (BTL), so called synfuels, which are mainly planned to substitute conventional diesel. In Germany, a first production plant for such fuels using the Fischer-Tropsch-process was built in 2008. It has a production capacity of 18 million litres of BTL and production is starting up this year. Also in Brazil, there are efforts to use this technology. A pilot plant with integrated biomass gasification has been running since 2008, a demonstration plant is planned for 2011 [8]. Sousa-Aguiar [9] estimates the potential of BTL production in Brazil. This would be equivalent to almost 19% of the country's primary energy consumption. Such synfuels can be converted from various biomass feedstocks, mainly lignocellulosic materials, including waste materials from households, agriculture etc. Generally, the utilization of lignocellulose as feedstock offers a wider range of raw materials and fuel production pathways as today's common technologies. Further developments are the conversion of lignocellulose into ethanol and improvements in the production of biogas ("synthetic natural gas") and hydrogen.

3 Fuel Scenarios

A strong reason for the implementation of an alternative fuels market, especially consisting of biofuels, are the environmental benefits surging from their use. Yet there are still discussions ongoing about the dimensions of such advantages. Most of the published studies analysing the benefits of biofuels confirm that the net emissions of carbon dioxide equivalents (CO_2 eq.) resulting from using biofuels are lower than those of conventional fuels. Figure 3 shows an overview of different renewable fuels that can be possibly produced. It further shows their net CO_2 eq. emissions compared to their fossil pendants. It becomes obvious that there are considerable variations in the performance of the biofuels. These differences result to a certain extent from different regions and ways of crop cultivation, transport distances, scale of production plants or methodology (e.g. assessment of NO_x emissions). Nevertheless, some pathways appear to be more favourable than others. Ethanol made from starch crops, for instance, causes higher emissions of CO_2 eq. than ethanol from other feedstock. Lignocellulose provides a great potential for reducing greenhouse gas emissions (GHG) emissions over the life cycle of liquid transportation fuels. Yet today they still play a minor role in commercial bioethanol production.

In general, future technologies, namely BTL ("biomass to liquid") fuels, improved biogas and hydrogen are expected to reduce the GHG emissions over their lifetime significantly compared to first generation fuels. The European Commission reported a potential of about 90 % in terms of CO_2 eq. savings [10] from these fuels, which lies within the range of today's Brazilian sugar cane production (Figure 3). Concerning hydrogen, the prospected GHG savings vary substantially. Dependent on the type of raw material, the production pathway and whether carbon sequestration technologies are applied or not, the use of hydrogen as fuel leads to a considerable increase or decrease with respect to the CO_2 eq. emissions over its whole life cycle.

Considering other ecological impacts than the greenhouse gas emissions, the utilization of biofuels is not necessarily advantageous. Critical aspects are, for instance, the increased usage of land and the environmental burdens arising from the application of fertilizers and pesticides associated with agricultural activities. In Brazil, for instance, new sugar cane plantations in the past few years lead to almost 2 million ha of new land cultivation [7]. Especially the elimination of primary rain forests, as it massively happened for palm oil production in Southeast Asia, must be seen critically, as the destruction of valuable ecosystems cannot be evaluated by considering greenhouse gas or energy balances. Nevertheless, for the transport sector, the main environmental focus and motivation for the use of biofuels is the reduction of GHG, and in this paper we will not go into detail concerning the overall environmental performance of such fuels.

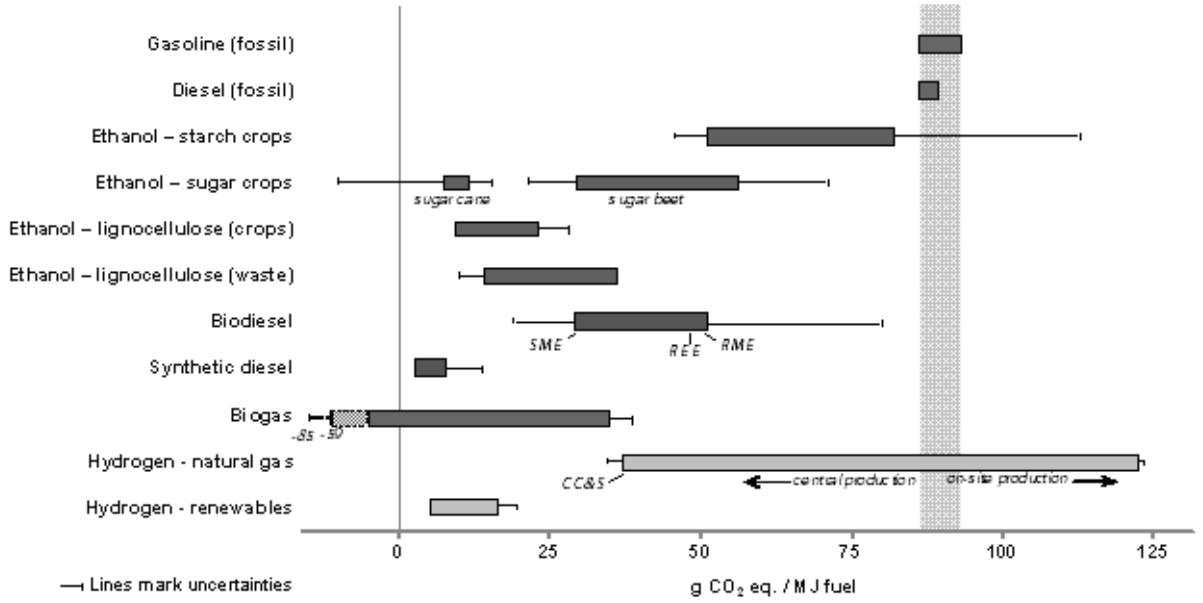

Figure 3: Net greenhouse gas emissions from biofuel supply [11]

Environmental favourable biofuels are not automatically the best choice concerning other aspects relevant for decision makers. Figure 4 shows status and potentials of production costs, net energy output and volume of production for the years 2005 and 2015. The data are mainly valid for German conditions as an example. We see that in 2005 the only mentionable production potentials result from biodiesel and bioethanol from starch crops, but that in a ten years time range other renewable fuels are expected to overtake these first generation propellants. Biogas and BTL are supposed to have a significant share of the total fuel market. These two fuel types also have the highest net energy output and are relatively low cost alternatives. In contrary, the utilization of bioethanol from lignocellulose, which has a significant GHG reduction potential (Figure 4), appears to be the most expensive choice associated with a relatively low net energy output per land area. Regarding today's most important biofuel in Germany, which is biodiesel, the graph shows the future potential is not expected to grow notably. Instead only marginal improvements in net energy output per area are predicted.

A study accomplished by the European Commission [13] estimates the costs for the society to meet the EU biofuel targets in 2010 to about € 6 billion per year. It assumes that the regulated market-based approach, which represents today's policy and aims to bring EU domestic biofuel industry in balance with imports, will not be subject to policy changes. To evaluate the economic effectiveness of the world's biofuel market development, these costs would have to be weighed against the external costs of environmental damages and other benefits.

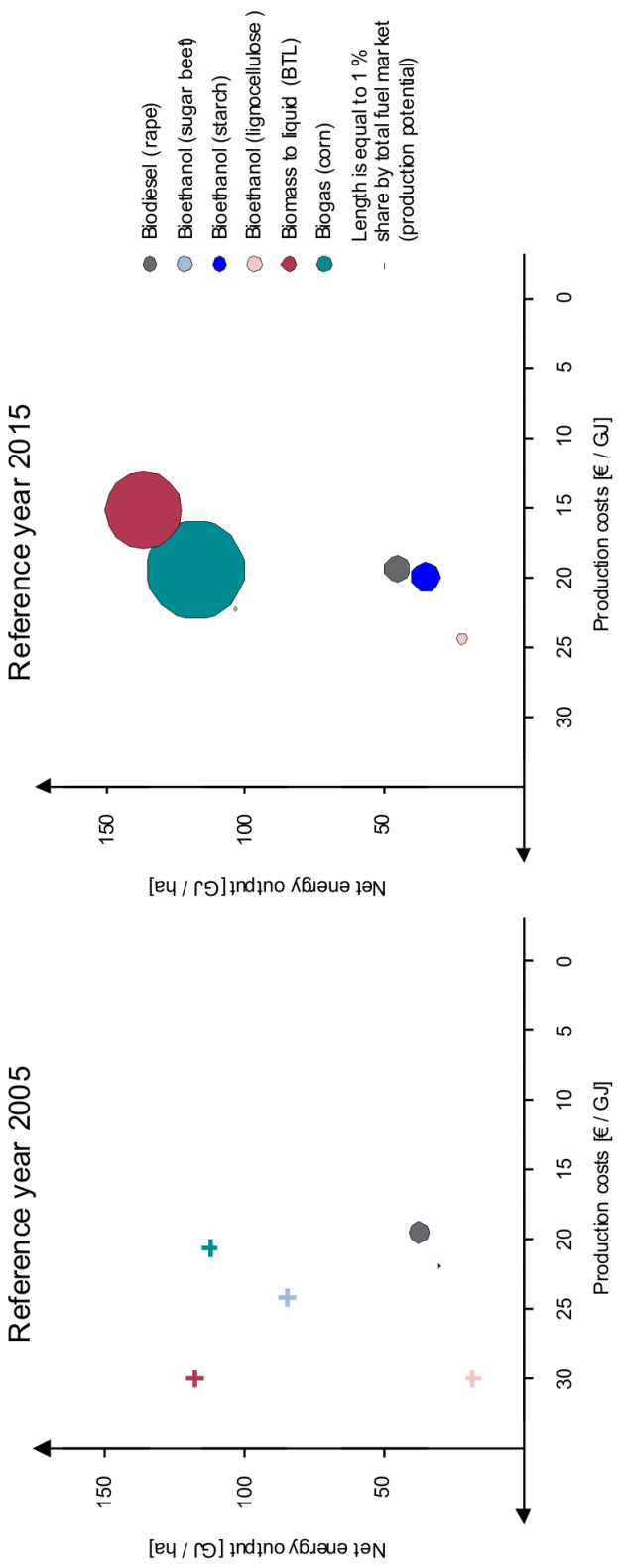

Figure 4: Net energy output, production costs and production potential of biofuels in Germany 2005 and 2015; crosses mark a zero potential for the respective biofuel (Data from [12]).

4 Vehicle Technology for Alternative Fuels

In order to approach the overall objective of greenhouse gas emission reduction, alternative transport fuels compete with other vehicle technologies which can lower fuel consumption – at least in the near future. In the long term perspective, probably only the overall efforts, low carbon fuels combined with highly efficient propulsion systems, might lead to the desired GHG-emission reduction. On the other hand, alternative fuels might need dedicated adaptations to the engine and the vehicle concept compared to conventional gasoline or diesel drive trains. Well-known examples are vehicles which use compressed gas, e.g. compressed natural gas (CNG, fossil), substitute natural gas (SNG, renewable) or biogas (renewable).

Figure 5 shows CO_2 emissions at the tail pipe for compressed gas vehicles with increasing degree of optimisation and hybrid electric power supply compared to a naturally aspirated spark ignited gasoline engine. Because of the high hydrogen content of methane in natural or substitute natural gas, up to 20 % lower CO_2 emission can be expected from compressed gas engines. The disadvantage of compressed gas is the high oxygen rate needed, which leads to a low heating value of the fuel-air-mixture in conventional spark-ignited engines. Therefore, the principal advantage of higher knock resistance is lost without modification of the spark ignited engine. However, the combination of alternative fuel, dedicated engine and hybridisation of the powertrain shows tremendous CO_2 savings potential. This potential becomes even higher, if a substitute of natural gas based on biomass is used.

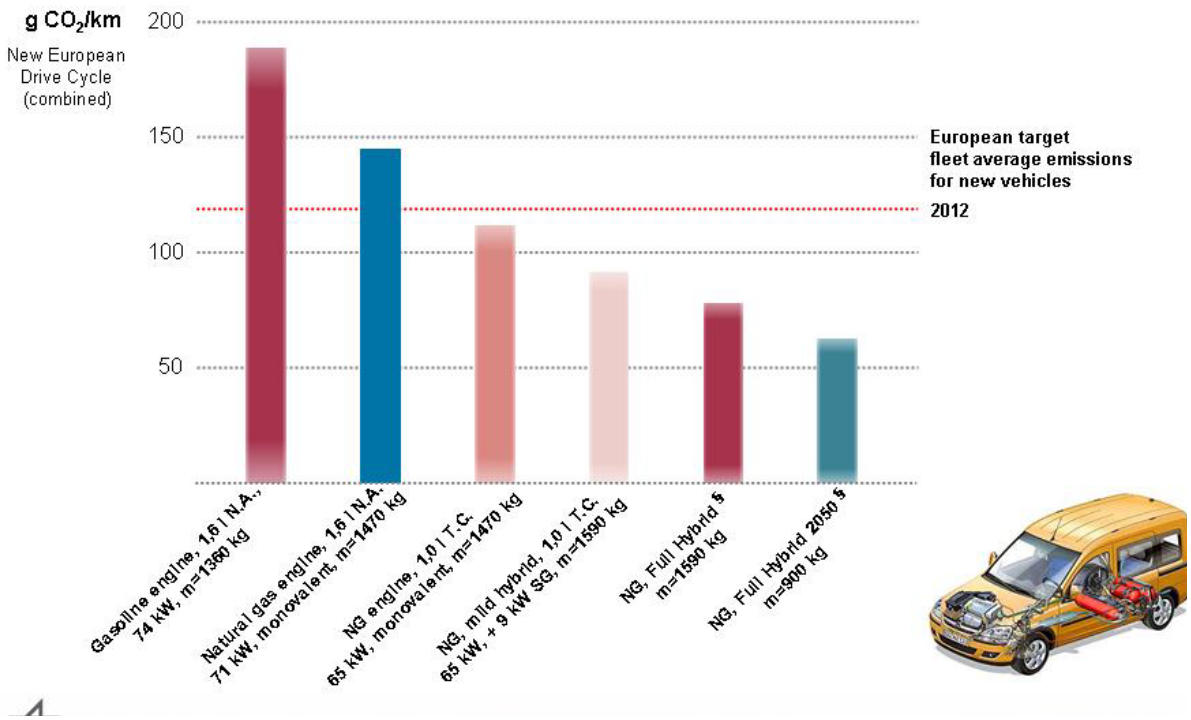

Figure 5: Compressed gas power train (natural gas or biomethan) in a middle class passenger car with increasing engine optimisation and hybridisation level compared to gasoline engine (Source: own estimates based on Berner [14]).

Another problem with compressed gas vehicles is the increase of vehicle weight due to the high pressure storage vessel. Alternatively, low cost concepts in order to avoid the use of heavy steel vessel would significantly encourage the use of compressed gas in vehicles. Figure 6 shows a tank concept under development which aims at combining high strength fibres with low cost injection moulding techniques.

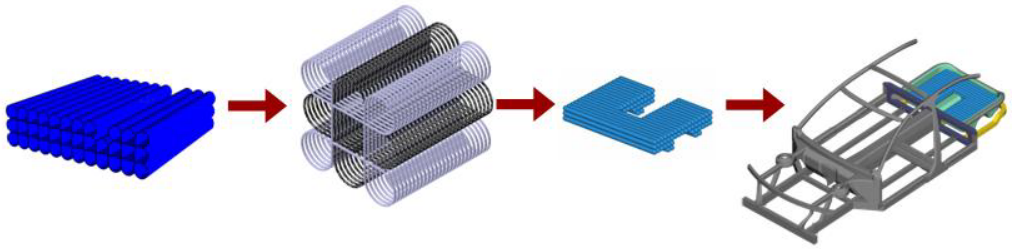

Figure 6: Injection moulding concept for advanced natural gas tank (Source: DLR, Institute of Vehicle Concepts)

In contrast to the example above, where the engine and vehicle technology adapts to the fuel, there is also the effort to design the fuel to the needs of the future engine technology. This can be accomplished by gasification of biomass with subsequent synthesis of liquid biofuels e.g. so-called Fischer-Tropsch (FT) Diesel. Compared to fossil diesel, synthetic diesel has less organic residues and can be produced to fit to future combustion concepts like e.g. HCCI (homogenous charge compression ignition).

From the vehicle technology perspective, the use of clean liquid fuels is seen as a favourable pathway in order to meet cost, CO_2 and emission targets.

Fuel cell vehicles are often referred to as the final step in the chain of propulsion technology.

Here, it is less obvious if hydrogen as a fuel has to be utilised because there is a need to store fluctuating renewable energy in the energy system or if the characteristics of the fuel cell (high efficiency, especially combined with pure hydrogen) makes the provision of hydrogen as a fuel more or less necessary. Nevertheless, although a number of prototype fuel cell vehicles have been presented by research and industry, the status of hydrogen technologies is insufficient today for a broad market introduction. Durability, lower operating temperature range and costs need to be improved for the fuel cell and safety and low energy density of hydrogen storage systems need to be enhanced. Therefore considerable more research and experience are required before this concept can be used widely throughout the world.

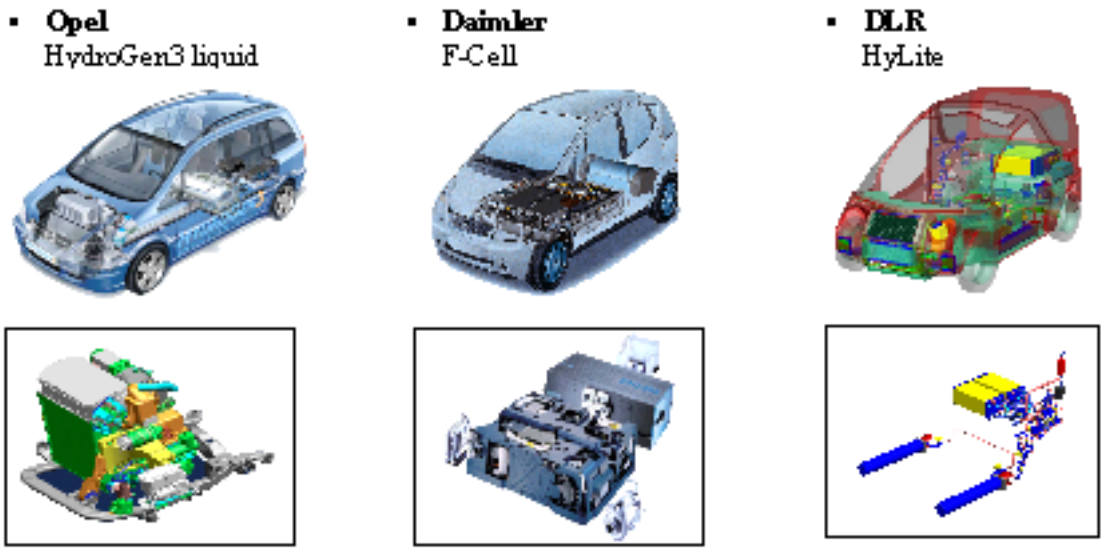

Figure 7: Examples of fuel cell vehicle concepts (Source: Adam Opel GmbH, Daimler AG, DLR, Stuttgart).

5 Conclusions / Outlook

Biofuels production and consumption worldwide is expected to grow in the future. Political targets, investment activities of industry and the trend of increasing demand in the last five years confirm this trend. Present biofuel production shows a positive tendency with respect to the net CO_{2eq} advantage. However for reasons of feedstock potential by area and interference with food production (which has to be avoided by all means), the development of second generation biofuels with 'non-food feedstock' must be given a high priority. As the use of biofuels is not beneficial per se from an environmental point of view, setting standards for biofuel production will be a primary political task in the future. This will ensure that the main purpose of such alternative fuels remains the reduction of greenhouse gas emissions.

Further improving the vehicle efficiency due to new technologies is essential to reach future CO_2 targets in the transport sector. This includes e.g. lightweight design of vehicles and the development of new alternative drive train technologies using batteries and fuel cells. The fuel market in general shows several alternatives such as different biofuels, natural gas and biogas that will penetrate the market at the same time. For good reasons, hydrogen and electricity might additionally enter the market. There are many challenges in the future in order to find the most economic and ecologic efficient solution.

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Taufbecken im Rheinisch-Bergischen-Kreis am Beispiel in Rösraths

Prof. Dr. Michael Werling

Herrn Prof. Dr. Hartmut Gaese zur geneigten Lektüre zugedacht, aber auch zur Erinnerung an eine angenehme und überaus faire Zusammenarbeit.

Unter einem Taufbecken, Taufstein oder Taufbrunnen - kurz und allumfassend auch Taufe genannt - versteht man jeweils jenes Behältnis, an dem in christlichen Kirchen die Taufe vollzogen wird. Ein Taufbecken gehört zu den wichtigsten Liturgiegeräten (sog. Prinzipalstücke) in der Kirche und ist daher auch in der Regel in jeder Pfarrkirche zu finden, da der Mensch erst durch die Taufe in die christliche Gemeinschaft aufgenommen wird.

In früheren Zeiten durfte man erst dann einen geheiligten Raum betreten und am gesamten Gottesdienst teilnehmen, wenn man dieses Sakrament erhalten hatte. Sowohl in der katholischen als auch in der evangelischen Kirche wird dem Taufbecken, das sich häufig im Eingangsbereich einer Kirche oder in einer eigenen Taufkapelle befindet, eine große Bedeutung beigemessen. Seine Aufgabe besteht nicht nur darin, das in der Osternacht geweihte Taufwasser während der Osterzeit in der Cuppa aufzubewahren, sondern der wichtigen Taufzeremonie auch einen würdigen Rahmen zu verleihen.

Die Gestaltung des Taufbeckens hängt unmittelbar mit der historischen Entwicklung des Taufritus und der stilistischen Entwicklung in der Architektur zusammen. Grundsätzlich unterscheiden wir drei Formen der Taufe: Das vollständige Untertauchen (Immersio), das Be- oder Übergießen mit Wasser (Infusio) und das Besprengen (Aspersio). Das Untertauchen dürfte wohl biblisch die korrekteste Art der Taufe sein. Auch das griechische Wort „baptisma“ (= Taufe) heißt Ganzwaschung im Sinne des Untertauchens. Dafür waren keine besonderen Vorrichtungen erforderlich, denn nach Matthäus (3, 13-17) ließ sich Jesus von Johannes im Jordan taufen. Auch seine Nachfolger benötigten keine Taufvorrichtung und keinen bestimmten Taufort. Waren geeignete Wasserstellen vorhanden, wurde die Taufe durch vollständiges Untertauchen des Täuflings vollzogen. Dies lässt sich recht deutlich auch aus der Apostelgeschichte (8, 36-39) entnehmen. Und auch Petrus soll in Rom noch vor den ersten Christenverfolgungen das Sakrament der Taufe im Tiber gespendet haben.

Während der Zeit der Christenverfolgung verlegte man oft die Feier der Eucharistie und der Taufe in die über 60 Katakomben von Rom. An diesen unterirdischen Zufluchtsorten lassen sich heute noch entsprechende Vertiefungen lokalisieren, die als Taufbecken in den Fels geschlagen wurden. In einigen Kammern findet man sogar Abbildungen die darstellen, wie ein Täufling etwa hüfttief im Wasser steht, während der Täufer ihm aus einem Gefäß Wasser über den Kopf

gießt. Erst durch das sog. Toleranzedikt von Mailand (313 n. Chr.) enden Verfolgung und Leid. Der Kaiser des Westens, Konstantin I. und der Kaiser des Ostens, Licinius, gewähren sowohl den Christen als überhaupt allen Menschen die Freiheit in der Wahl ihrer Religion. Dieses Zwei-Kaiser-Abkommen verursachte bei den Christen natürlich sofort den Bau von Taufstätten.

Da zur Zeit der großen Missionierung in erster Linie Menschen im entscheidungsfähigen Alter getauft wurden, entschied man sich für einen gesonderten Taufraum in unmittelbarer Nachbarschaft der Kirche. Diese sog. Baptisterien oder Taufkirchen sind in der Regel als Zentralbauten über einem viereckigen, runden, polygonen oder vornehmlich im Osten auch über einem kreuzförmigen Grundriss entwickelt. In der Mitte dieser Anlagen ist ein großes Taufbecken, eine sog. Piscina angeordnet, gelegentlich von einem Säulenkranz umgeben, über dem sich ein Baldachin bzw. Ciborium erhob. Da die Taufe immer noch durch vollständiges Untertauchen oder durch Übergießen des im Wasser stehenden Täuflings vollzogen wurde, waren jeweils große Taufbecken erforderlich. Die Baptisterien waren oft auch deshalb von beträchtlichen Dimensionen, weil das Taufritual nur an bestimmten Tagen im Kirchenjahr, nämlich an Ostern (Fest der Auerstehung Christi) und Pfingsten (Ende der Osterzeit und Ausgießung des Hl. Geistes) stattfinden durfte.

Als ab der Karolingerzeit die Zahl der Kindertaufen zunahm, wurden die von den der Kirche unabhängig errichteten Baptisterien seltener und aus der im Boden eingelassenen großformatigen Piscina entwickelte sich das Taufbecken in Form von Sockel, Schaft und Cuppa. Die Tatsache, dass man im 12. Jh. dazu überging, den Täufling nur noch mit Weihwasser zu übergießen oder zu besprengen, ließ das Taufgerät zunehmend schlanker und kleiner werden.

Zur Situation im Rheinisch-Bergischen-Kreis

Da das Taufbecken neben Altar und Ambo zu den Prinzipalstücken einer Kirche gehört und somit in jeder Kirche mindestens einmal vorhanden ist, lässt sich ein recht genauer Überblick über die Situation im Rheinisch-Bergischen-Kreis festhalten. Insgesamt sind es 76 Taufsteine bzw. Taufen, die vom 12.Jh. bis in das 21. Jh. datiert werden können.

Die Taufen der romanischen Zeit zeichnen sich v.a. dadurch aus, dass ihre Glieder durchweg breit und schwerfällig angelegt sind. Die Cuppa ist in der Regel rund oder sechseckig, der sie tragende Schaft besteht entweder nur aus einem Mittelzylinder oder er wird zusätzlich durch weitere Säulchen ergänzt, die v.a. den Rand des Beckens stützen helfen. Die ursprünglichen vermutlich aus Holz bestehenden Taufsteindeckel sind längst nicht mehr erhalten, sodass heute moderne Abdeckungen, in der Regel aus Metall, die Taufen zieren.

Für die gotische Epoche, in der die einzelnen Elemente merklich schlanker werden, bzw. an Höhe gewinnen und wo v.a. plastische Verzierungen Cuppa und Deckel schmücken, gibt es im Untersuchungsgebiet kein Beispiel mehr.

Lediglich aus der Zeit des Barock gibt es wieder einige Taufen, welche die Lust am Schmücken und Profilieren erkennen lassen. Der Cuppa liegt mittlerweile das Achteck zugrunde, die Sockelausbildungen sind mehrfach getreppt und gestuft ausgeführt und die Schaftausbildungen gleichen balusterartigen Architekturelementen.

Sehr viele Taufen sind allerdings aus dem 19. Jh. vorhanden. Sie verfügen mehrheitlich über die schon erwähnte polygonale Cuppa. Im Zuge des Historismus sind romanische und gotische Verzierungen und Muster sehr häufig anzutreffen, d.h., die Sockel zeigen attische Basen einschließlich Eckzier, die Schäfte werden mit Blendmaßwerk versehen und die Beckenwandungen zeigen ebenfalls reichlich Blatt- und Rankenwerk, bzw. filigrane steinmetzmäßig bearbeitete Dekorationen. Die dazugehörigen Taufdeckel sind entweder aus Holz oder in Metall gefertigt. Sie sind der achteckigen Cuppa angepasst, verziert und in der Regel mehrfach gestuft und geschwungen gearbeitet und mit einem Kreuz, Blattzapfen oder Taubenmotiv als Bekrönung abgeschlossen.

Seit der Mitte des 20. Jh. lässt sich wieder eine Vereinfachung des Stils in Form und Verzierung feststellen. Die klassische Grundstruktur in Form von Sockel, Schaft und Cuppa, die über die Jahrhunderte konstant beibehalten wurde, wird sukzessive aufgegeben. Nun steht das Zurücktreten rein ästhetischer Gestaltungsprinzipien im Vordergrund.

Was die Inschriften betrifft, so überwiegen die Zitate aus dem Neuen Testament:

„Wer da glaubet und getauft wird, der wird selig werden“ (Mk. 16, 16) und „Lasset die Kindlein zu mir kommen und wehret ihnen nicht denn solcher ist das Reich Gottes“ (Mk. 10, 14) oder „Taufet sie im Namen des Vaters und des Sohnes und des Heiligen Geistes, und lehret sie, alles halten, was ich euch geboten habe“ (Mt. 28, 19-20) bzw. „In der Taufe mit Christus begraben, seid ihr mit ihm auch auferstanden“ (Kol. 2, 12).

Das für die Taufen verwendete Material ist in der Regel der Naturstein. Bei den Romanisch/Gotischen lässt sich eine Bevorzugung des Trachyts aus dem Siebengebirge feststellen. Die in barocker Zeit gefertigten Taufen sind überwiegend aus Lindlarer Marmor hergestellt. Bei den modernen Taufen kommen die unterschiedlichsten Materialien zum Einsatz. Die Spanne reicht vom Metall über den Natur- und Kunststein bis hin zu den unterschiedlichsten Holzarten.

Bei den noch der Romanik verhafteten Taufen lassen sich im Bereich der Cuppa maskenhafte Köpfe und dämonenartige Fabeltiere einschließlich stilisierter Pflanzendarstellungen feststellen. Sie stellen allesamt Dämonen dar, stehen für die in der Welt andrängenden Laster und Sünden, welche durch die Taufe bezwungen werden können. Bei den jüngeren Taufen tauchen vereinzelt an den Cuppawandungen angearbeitete Reliefs auf, welche die Sakramente bzw. Motive des alten und neuen Testaments zum Thema haben.

Drei Beispiele aus Rösrath

Anhand der folgenden drei Tafeln bzw. Abbildungen von Taufen in Rösrather Gotteshäusern sei die stilistische Entwicklung dieses so wichtigen Liturgiegerätes aufgezeigt.

Die Taufe der Romanik, dargestellt an der ev. Kirche in Rösrath-Volberg (12. Jh.)

Ort: **Volberg**
Stadt Rösrath
Ev. Kirche

Alter: 12. Jh.

Material: Trachyt aus dem Siebengebirge.

Größe: H = 96 cm, Ø = 105 cm.

Beschreibung: Die Taufe besteht aus zwei Teilen. Ein aus unserer Zeit stammender säulenförmiger Mittelzylinder trägt, wie ehemals wieder, die noch aus romanischer Zeit stammende Cuppa. Ihr Zustand ist roh und zuweilen nicht ganz im richtigen Winkel behauen. Der obere Abschluss der weit ausladenden Cuppa bildet ein sechseckiges Gesims von vorspringenden kleinen Rundbogen. Sechs ehemals freistehende schlanke Säulchen umstellten den Kessel bzw. stützten den Beckenrand, wie man an den noch vorhandenen Ansätzen erkennen kann. Da eine Kapitellausbildung fehlt, dürften auch die Basen der Stützglieder minimalistisch ausgefallen sein. Die Schalenvertiefung ist halbkugelförmig in den Stein eingehauen. Als Abdeckung dient heute eine aus geschweiften schmiedeeisernen Stäben hergestellte Absperrvorrichtung.

Farbfassung: Der Stein ist ungefasst.

Künstler: unbekannter Steinmetz aus dem Siebengebirge.

Standort: Der rom. Taufstein ist in der Turmkapelle, die heute als Sakristei genutzt wird, aufgestellt.

Kirche: Die Anfänge der romanischen Vorgängerkirche lassen sich zeitlich nicht mehr exakt fassen. Für das 9. Jh. ist zumindest eine Eigenkapelle (mit Priester) und um 1275 eine Pfarrkirche bezeugt. Der heutige Sakralbau wurde im Wesentlichen in der Zeit zwischen 1788-90 errichtet. Lediglich das Turmuntergeschoß einschließlich der Apsis stammt noch aus dem 12. Jh.

Die Taufe des Barock, dargestellt an der kath. Kirche St. Nikolaus von Tolentino in Rösrath (um 1700)

Ort: **Rösrath**
(Zentrum)
Kath. Kirche St. Nikolaus von Tolentino
und ehem. Augustiner-Eremiten-Kloster

Alter: um 1700

Material: Schwarzer Marmor, Messing

Größe: H = 112 cm, Ø = 47 cm.

Beschreibung: Der quadratische Sockel ist mehrfach geschwungen und getreppt gegliedert. Darauf steht der ebenfalls quadratische, balusterartige Schaft. Die achteckige Cuppa ist passgenau mit einem quadratischen Sockel aufgesetzt. Der obere Abschlussrand des Beckens ist profiliert. Die Schalenvertiefung ist als Halbkugel gearbeitet. Eine neue Messinghaube, bekrönt von einer Kugel auf der eine Taube mit ausgebreiteten Flügeln sitzt, schließt die Taufe. Er ist an der Cuppa mit einem Scharnier befestigt.

Farbfassung: ungefasst

Künstler: Vielleicht war es der angesehene Lindlarer Steinhauermeister Leonhard Gutherr (1660-1724), der diese Taufe gefertigt hat. Zumindest passt das Zeitfenster der Erbauung der Kirche mit den Lebensdaten dieses quasi in der Nachbarschaft lebenden Künstlers überein.

Standort: In der Südwand des zweiten östlichen Jochs ist eine etwas tiefer gelegene Taufkapelle eingelassen, in der sich das Taufbecken befindet.

Kirche: Die Kirche besitzt die Form einer einschiffigen, kreuzrippengewölbten Hallenkirche mit einer polygonalen Apsis auf der Ostseite. Errichtet wurde sie in der Zeit zwischen 1691-1703. Zu Beginn des 20. Jh. ist der Sakralbau wegen Baufälligkeit bis auf die Unterkante der Fenster abgetragen und neu aufgemauert worden. Eine weitere Renovierung erfolgte in den Jahren 1982/84 unter Arch. G. Hagen.

Die Taufe der Moderne, dargestellt an der ev. Versöhnungskirche in Rösrath (1967)

Ort: **Rösrath**
(Zentrum)
Ev. Versöhnungskirche

Alter: 1967

Material: Stahl, Anröchter Grünsandstein

Größe: H = 90 cm, Ø = 65 cm.

Beschreibung: Die Taufe besteht aus zwei Teilen. Als Unterbau dient ein umlaufender Stahlrahmen an den an jeder Ecke jeweils zwei Tischbeine, ebenfalls aus Quadratrohr, angeschweißt sind. Diese bilden in ihrer Grundrissstruktur ein gleichschenkeliges Kreuz. Die schmucklose Cuppa ist in Form eines Quaders dem Rahmen aufgelegt. Als Schalenvertiefung dient auf der Oberseite eine flache Halbkugel.

Farbfassung: Die Taufe ist ungefasst.

Künstler: Der Entwurf der Taufe geht auf den Architekten der Kirche Horst Welsch zurück.

Standort: Die Taufe steht noch auf Saalniveau vor dem leicht erhöhten Altarbezirk.

Kirche: Das Kirchenschiff hat die Form eines Schiffsbuges. Ein dominanter Turm, der am Kopf spiralförmig ausläuft, ist dem Sakralbau beigefügt. Errichtet wurde die Kirche einschl. des Gemeindezentrums im Jahre 1967 durch Arch. Horst Welsch.

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