



Sustainability Standards for internationally traded Biomass

Sustainable Biomass Production in China

– Terms of Reference –

prepared for UBA/BMU

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1 Background and Aims

The use of biomass for energy production is rising globally in parallel to increasing oil prices, concerns with energy security, and climate change. Many countries recognize biomass as a domestic energy resource, and some see opportunities for exports of liquid biofuels. With political goals of e.g., the EU to increase the use of biofuels in the transport sector from a current rate of 2% up to 10% in 2020, and domestic biofuel quota systems being introduced in many other countries as well, there is little doubt that biomass use for liquid transport fuels, as well as for electricity and heat production, will continue to rise in the future, and that global trade with bioenergy will rise correspondingly. This will pose both opportunities and risks for sustainable development of regions, countries, and globally.

In this context, the Federal Environment Agency (UBA), on behalf of the German Ministry for Environment (BMU), is funding a research project on sustainable global biomass trade (Bio-Global), carried out by Oeko-Institut and IFEU through the end of 2009. The project includes methodical aspects concerning climate protection, biodiversity, water and land use, as well as aspects related to bioenergy trade and legal concerns (e.g., the World Trade Organisation and bilateral agreements). A key element in this research is the consideration and elaboration of business and trade opportunities for sustainable biomass feedstock provision which have no negative impact or which has even positive environmental, biodiversity, climate, and social trade-offs.

The cultivation of biomass on abandoned farmland and especially on unused degraded land could safeguard against negative indirect land-use change effects from bioenergy development: As no displacement of previous cultivation occurs, biomass production from these lands will not increase pressure on protected areas and unprotected biodiversity-relevant areas by indirect land-use change. Thus, abandoned farmland and unused degraded land appear to be priority areas for biomass production **if** they are neither sensitive to cultivation nor used by local people.

However, at least some of these areas might harbour high biodiversity and could belong either to protected areas or other biodiversity-relevant areas, and the regeneration of degraded land toward natural habitats may be more beneficial. Therefore the status of these areas needs to be evaluated carefully.

Within the Bio-Global project, country case studies will be carried out that aim:

- to provide GIS data for mapping of abandoned and degraded land and biodiversity-relevant areas on a national and sub-national scale, and to compare these data with globally available results of mapping;
- to identify potential sustainable bioenergy production areas with a focus on degraded land, abandoned farmland as well as natural unused areas;
- to identify sustainable cultivation systems for these areas;
- to check the achieved results of GIS analysis (top-down) with selected data from the field, involving respective stakeholders (bottom up); and finally
- to draw up a positive list of area types, including their spatial mapping, where sustainable biomass production has clear positive effects and very low risks for negative ones.

2 Terms of Reference

The contractor, a consortium of the University of Science and Technology Beijing (USTB – consortium leader), the China Meteorological Association (CMA), Spatial Analysis Center at Jiuzhaigou National Park (JNP) (technical coordinator), and the Chinese Academy of Agricultural Science (CAAS) is expected to have excellent experience in mapping and GIS data analyses as well as sound knowledge on related land information in the People's Republic of China.

In addition, the contractor needs knowledge on and access to global data, especially those listed in Appendix 1. This data are the basis for the further work defined in this Terms of Reference.

In addition, project papers (OEKO 2008a, 2008b, 2008c) as well as recent published papers on the topic will be handed over by Öko-Institut to the contractor and will be considered as a base for the work to be carried out (see list of publication in Appendix 2).

If requested, data and documents collected and used by the contractor will be made available to the Öko-Institut.

2.1 Work package 1: Brief Overview Paper on the Availability on Spatial Data

The first task – managed by the Chinese Meteorological Association (CMA) - is to prepare a **brief overview paper** on the **availability on spatial data for the People's Republic of China** regarding the topics listed below. Here, data on different scales need to be considered. A focus is set on regional, national and also sub-national data that will be compared with global data (those mentioned in the introduction and others – if reasonable). Information for the data is given regarding resolution, frequency of updating, data quality, costs and availability. As a focus topic, the paper includes information on “degradation-area-types” and cases of land degradation. Also definitions for relevant land categories used within databases are given and possible differences between definitions from different databases are reviewed.

List of topics:

- a. Degradation land
- b. Abandoned land
- c. Unused (“natural”) land
- d. Land-use data
- e. Suitability maps for cropping
- f. Soil quality
- g. Biodiversity relevant areas
- h. Other special data that can be used to derive information on the upper categories
- i. Social aspects: data on local people and their livelihoods (subsistence farming, land tenure etc.)

2.2 Work package 2: Spatial Identification of Potential Areas for Biomass Production

The second task – managed by the Spatial Analysis Center at Jiuzhaigou National Park (JNP) - is to prepare relevant available data from global to national scale identified under point 2.1 are provided in **GIS format** (ArcGIS-compatible).

In cooperation with the Öko-Institut, the contractor (here the consortium member: Spatial Analysis Center at Jiuzhaigou National Park (JNP)) will develop a first **draft decision tree to identify potential**

areas for biomass production that is in line with sustainability requirements of EU standards and specified for conditions in China.

A focus of the decision tree will be the sustainable production of biomass on degraded land, abandoned land and unused natural land while negative impacts on environment (greenhouse gas, biodiversity, soil, water) and local people (food security, local land use) are minimised.

For the People's Republic of China, **potential areas for biomass production are identified** by applying the developed decision tree (top-down) with a special focus on identifying degraded land. This is done on two special scales considering

- (1) global available GIS-data only;
- (2) all identified GIS-data from global, national to sub-national scale.

The results are provided in GIS format (ArcGIS-compatible).

A **paper** will present the decision tree for China, the identified potential areas for bioenergy production on the two scales mentioned above as well as the comparison of the latter results.

2.3 Work package 3: Cultivation Systems and Calculation of Biomass Potentials

The third task – managed by the Chinese Academy of Agricultural Science (CAAS) - is to prepare a view on the identified potential areas for biomass production. The draft **decision tree to define sustainable cultivation systems** (see work package 2.2.) is further developed in cooperation with all consortium partner in a workshop organized within CAAS, so that it is in line with sustainability requirements of EU standards and tailored to suit conditions in China. The decision tree is then applied by CAAS to choose **5-10 sustainable cultivation systems** based on different energy crops, from which **three examples** are selected for more detailed description. These examples are selected to cover a large proportion of the identified potential areas for biomass production (point 2.2) and at least two of them can be used for cultivation of biomass on degraded sites in China. These cultivation systems are described regarding their cultivation practices (e.g., cultivated crops, inputs needed, machining), investment and operation costs, their yields and income per area, and their environmental (greenhouse gases, soil, water and biodiversity) as well as social impacts. The latter description considers cultivation on degraded land as a special focus and compares it to cultivation on non-degraded land. Based on this information, **biomass production potential** is calculated and extrapolated for China.

The decision tree for sustainable cultivation systems, the sustainable cultivation systems and the results for the calculation of biomass potentials are presented in **analysis paper format**.

2.4 Work package 4: Prove of the Reliability of the Top-down Identification of Areas for Biomass Production

The fourth task – managed by the University of Science and Technology Beijing (USTB) - is to prepare based on the identification of potential areas for biomass production under point 2.2 and 2.3, **two focus areas** with high amount of potential areas for biomass production are selected. The focus areas have a size of at least 100 ha and they cover in a reasonable manner different types of available land (e.g., degraded land, abandoned land, and unused natural land).

For each of these two focus areas, a **site visit** is organised together with policy makers, NGOs, local people and other relevant stakeholders. During the site visit it is proven if the areas identified by the top-

down analysis are really available and suitable for sustainable bioenergy production (bottom-up). The results of this prove for the two focus areas are presented in a **brief paper**.

2.5 Work package 5: Positive List of Habitats for Biomass Production

The fifth task - managed by the Spatial Analysis Group at Jiuzhaigou National Park (JNP) - is to prepare the results from point 2.1 to 2.4 together with the Öko-Institut to develop a **methodology** (including standards and requirements) to define areas types (habitats) where sustainable biomass production has clear positive effects and very low risks for negative effects. This is then specified and applied for China resulting in a **positive list** of area types for sustainable biomass production. The location of these area types are mapped and provided in a GIS format (ArcGIS compatible), and a **brief paper** presenting the methodology and results. A draft version of this brief paper will be discussed before within the consortium in a final workshop organized within JNP.

2.6 Presentation of Results

- The described papers regarding work package 1-5 (points 2.1 to 2.5)
- Set of GIS-data (ArcGIS-compatible) identified, used and processed within work package 1-5 (points 2.1 to 2.5)
- Presentation of the results on an international workshop organized by the Öko-Institut (possible locations: South Africa, China, Paris or Berlin)

3 Timetable and Cost Schedule

The overall cost of the work will be Euro 26,000, including travel costs inside China.

Each of the four consortium members will have a lump-sum budget of 5,750 Euro, plus 500 Euro each for CAAS and JNP for the two workshops (print material, room and equipment), and 1,000 Euro for USTB and JNP each for administrative and coordination overheads.

Timetable

Work Package	Schedule	Tasks	Notes
1. Brief Overview Paper on the Availability of Spatial Data	<ul style="list-style-type: none"> November-December 2008 	Kick-Off meeting at USTB or CMA in Beijing, Friday, 14th November 2008	Research Paper provided to the Öko-Institut for correction end of February 2009
2. Spatial Identification of Potential Areas for Biomass Production	<ul style="list-style-type: none"> November 2008-March February 2009 	<ul style="list-style-type: none"> CMA: Creation of GIS compatible mapping and database data JNP: Developing draft Decision Tree Analysis 	Research Paper provided to the Öko-Institut for correction end of March 2009
3. Cultivation Systems and Calculation of Biomass Potential	<ul style="list-style-type: none"> November 2008-January 2009 February 2009 	<ul style="list-style-type: none"> CAAS: Data Assessment and Analysis, Decision Tree Tool creation, testing and application CAAS: Workshop in Beijing after Spring Festival 	Research Paper provided to the Öko-Institut for correction end of February 2009
4. Proof of the Reliability of Top Down Identification of Areas for Biomass Production	<ul style="list-style-type: none"> January 2009-March 2009 February-March 2009 	<ul style="list-style-type: none"> All: Continuation of Desk Study, data creation in GIS Format USTB: Site Visits 	*
5. Positive List of Habitats for Biomass Production	December 2008-January 2009	JNP: Development of draft paper and Workshop discussion with Working Group, in Dialogue with Öko-Institut	*

Notes

*The work defined in work package 1-5 (points 2.1 to 2.5) shall be finalised by the end of April 2009. Paper of work packages 1 and 3 shall be provided to the Öko-Institut for correction by end of February, and paper of work packages 2, 4 and 5 at the end of March 2009.

4 Team composition

By demand detailed CVs could be sent.

4.1 USTB

4.1.1 Prof. Dr.-Ing. Li Zifu, consortium team leader for the study

Since 2004 he is Professor at the School of Civil & Environmental Engineering of the University of Science and Technology Beijing (USTB), Committee Member of Environmental Economics Committee of the Chinese Environmental Science Association, Expert for environmental assessment and wastewater management, he has been working since 1988, first at the Anhui Institute of Architectural Engineering, then as Deputy Director of Haikou City Water Supply Office, and from 1997 to 2004 in Germany at the University of Applied Sciences in North-East-Lower-Saxony in the Master Program of Water Management in Tropical and Subtropical Regions, than to obtain the Dr.-Ing. at the Institute for wastewater management, Technical University Hamburg-Harburg and then as researcher and lecturer at the University Duisburg-Essen.

4.1.2 Mario Lucas M.A.

Economic Geographer, Integrated expert (CIM-GTZ) and environmental Sciences expert at the USTB, Ph.D. candidate of Human Geography on "Energy consumption and environmental changes in three rural regions of China – Tibet Autonomous Region, Inner Mongolia and Shandong", studied before 2004 "Regional economic area analysis and economic promotion" at the RWTH Aachen University, department of applied geography, experienced in empirical study on the fields of energy consumption and its impact on natural and humanized environment, especially with regard to biomass, application of renewable energies, maintenance, transformation of educational and social structures, creating of R&D locations, he has proven research skills in spatial activity of environmental technologies, technology transfer China/USA.

4.1.3 Dipl.-Ing. Heinz-Peter Mang, organizational coordinator of the study

Integrated expert (CIM-GTZ) and Manager of the Centre for Sustainable Environmental Sanitation at the University of Science and Technology Beijing (USTB), Engineer BSc & MSc since 1980 for Energy- and Thermal Power, biomass energy expert working since 26 years internationally for UN-FAO, UN-IAEA, UNDP, GTZ, ADB in Asia, Africa and Latin America in the field of biogas, biofuel, biomass power and environmental sanitation; team leader of the ongoing EU agricultural biomass energy resource assessment in China, and already working in China on the same topic on behalf of KfW/DEG, ADB and GTZ and Chinese Ministry of Agriculture.

4.1.4 William Tze Ming Kao MSc.

Mechanical engineer (MSc), Biomass Feedstock Market Analyst, since 2004 Manager of the COBRA Biodiesel Division, Pro-Tek Electroplating Development Co. Ltd., Xiamen, he initiated the Shenyang Kitchen Waste Collection and Process Plant Project, he is working as GTZ China Consultant and Trainer for Rural Renewable Energy and Waste to Energy Projects, and he is a well known biomass energy feedstock analyst for Credit Suisse Energy Tours and for KfW/DEG applying GIS "on the ground" in China.

4.1.5 Elisabeth M. Huba M.A.

Master of Art in Social Science and Anthropology, Consultant in socio-cultural and socio-economic topics related to biomass energy and rural development, ecological agriculture and sanitation, poverty

reduction strategies and market access, works for over 26 years in international projects concerning ecological cycle production combined with agro-forestry and efficient biomass and energy management. Her work is carried out in cooperation with, and on behalf of local, national and international organizations, institutions and enterprises in Europe, Africa, Asia, North- and South America, focusing on participatory approach, intercultural communication and management as well as interactive training and consultancy methods. She worked i.e. for the final impact monitoring of the Sino-German Rural Energy Program, as socio-economist in a KfW-Biogas Audit team in Nepal through USTB, as World Bank Consultant for eco-sanitation strategy development in Uganda, and as social scientist for the Stockholm Environmental Institute in the Inner Mongolian eco-town project in Dongsheng and for local biomass energy resource assessments in China on behalf of KfW/DEG and ADB.

4.2 CAAS

4.2.1 Prof. Zhihao Qin

Professor in remote sensing at the Institute of Natural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing. Research interests: Remote sensing and GIS applications to agriculture, forestry, environment and natural resources; Environmental and micrometeorological modelling; Land-air-water interaction and energy/water balance; Spatial micro simulation and modelling; Landscape ecosystem analysis; Quantitative analysis and spatial statistics; Remote sensing image processing and analysis; Thermal remote sensing and algorithm development; GIS database development and applications. PhD, 2001, Dept. of Geography and Environmental Development, Ben Gurion University of the Negev, Beer Sheva, Israel. Major in remote sensing. Dissertation title: A study of temperature change on both sides of the Israel-Egypt Border: Remote sensing analysis and micrometeorological modeling. BSc., 1983, Dept. of Geography, Zhongshan University, Canton, China. Major in geography with focus on urban and regional planning.

4.2.2 Maofang Gao MSc.

Assistant professor since 2006 at the Department of Grass Sciences and Agricultural Ecology, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing. Research interests: GIS and remote sensing modeling; Remote sensing application to agriculture and environment, Agro-drought monitoring. MSc., 2006, International Institute for Earth System Science (ESSI), Nanjing University, Nanjing, China. Major in remote sensing and GIS. BSc., 2003, Department of Urban and Environmental Sciences, Northeast Normal University, Changchun, China. Major in physical geography.

4.2.3 Dr. Wilko Schweers

Integrated expert (CIM-GTZ) for Agricultural Water Resource Utilization at the Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences. Expertise and Research Interests International agricultural research cooperation (China): Partner and donor relations, advisory services, coordination and scientific writing, e.g. Ecosystems and Poverty Alleviation (ESPA) Project (<http://www.espachina.org/>); Groundwater resource investigation and agricultural water management in water-scarce regions (Aleppo, Syria): Abstraction volumes were established on the basis of water use monitoring and mapping of irrigated areas using GPS, GIS and satellite images. Pumping tests were performed in various locations to complement geophysical measurements. Potential water-saving irrigation strategies were evaluated in experiments with farmer cooperation. Environmental monitoring (Germany): Evaluation of the interaction of groundwater and saline surface water by piezometric observations, water analysis and bio-indicators. Mathematical surface water models and groundwater models were used to derive hydro-ecological parameters for finding the best location and composition of an alluvial forest. Research on animal-drawn farm implements (Ethiopia): A workshop for students' practical work and implement production was established at a junior college of agriculture. Farmers in nearby villages were equipped and trained in blacksmithing and woodwork. These farmers became

cooperation partners in the design of improved animal-drawn farm implements. Lowland rice (Portugal): Description of cultivation and water management of lowland rice in the different growing regions. Dr. agr., Kassel University, Rural Technology and Resource Protection, 1998. M.Sc., Cranfield University, Silsoe College, Bedford, UK, Land and Water Management, 1988. B.Sc., Kassel University, Germany, International Agriculture, 1986.

4.3 CMA

4.3.1 Prof. Dr. Jiang Tong

Professor in climate change, hydrology and water resources, at the Center on Climate Change, National Climate Centre, China Meteorological Administration, Dr. rer. nat. (Giessen University, Germany, 1999), Associate editor for Hydrological Sciences Journal (2005-2010), Editor of board of the Advanced in Climate Change Research (ACCR). Specialization: Climate change and impact on water cycle, Water Resources and Hydrological Modeling, International Cooperation, Exchange and Publication since 18 years. Since 2001: Member for IGU-risk assessment committee. Nowadays project investigator in a key project from German Research Foundation (DFG) : Climate change, hydrological extremes and impact on ecosystems in China and Centre director and project investigator of the China-German joint research centre for climate change and floods/droughts.

4.3.2 Dr. Marco Gemmer

Visiting Professor, Head of Unit and CIM Integrated Expert on Climate Change China Meteorological Administration (CMA), National Climate Centre (NCC), National Centre on Climate Change (NCCC), Integrated Expert (CIM-GTZ) for Climate Change Science and Policy Advise in cooperation with the Centrum für internationale Migration und Entwicklung (CIM). 2006 to 2008 Attaché, EU External Relations, European Commission, Delegation of the European Commission to China; Project Officer (Senior Adviser) for Environment and Energy, Management of EU-China Energy/Environment Programme, EU-China Biodiversity Programme, CDM Facilitation Programme, Proxy for EU-China River Basin Management Programme, Natural Forest Management Programme and 150 projects under the EU Asia Pro Eco Programme; 2004 Dr. Ph.D. in Natural Sciences, Justus Liebig University Giessen, Germany, Dissertation Thesis: Decision Support for Flood Risk Management at the Yangtze River by GIS/RS-based Flood Damage Estimation; 2001 M.Sc. in Geography, Political Science and Botany, Justus Liebig University Giessen, Germany.

4.4 JNP

4.4.1 Haoran Chen MSc.

GIS-Technician at the Jiuzhaigou National Park, Zhangzha Town, Aba Tibetan and Qiang Autonomous Prefecture, China; Engineering and natural resources protection construction project specialist with 5 years experience in project management and administration in China and the USA; 2008 Sichuan University, China; MSc in Environmental Engineering; 2001 Sichuan University, China; BEng in Engineering, Member of China Professional Engineers Association

4.4.2 Andrew Scanlon MSc., technical coordinator for the study

Integrated expert (CIM-GTZ) at the Jiuzhaigou National Park, Zhangzha Town, Aba Tibetan and Qiang Autonomous Prefecture, China; Biodiversity protection and natural resources management specialist with 10 years experience in project management and administration in Switzerland, Mexico, Ireland and China. 2004 University of East Anglia, UK; MSc in Environmental Management, 2001 Trinity College Dublin, Ireland; BA in Natural Sciences, Member of GSI (Geological Society of Ireland), Member of IUCN Working Group on Tourism in World Heritage Sites, Member of GTZ German government Natural Resources Working Group, UN Theme on Natural Resources, Equity and Human Rights Working Group, Board Member of Aba Nature Conservation NGO www.abanature.org.

5 Appendix 1 – Databases and Products

The following collection of databases and products related to the biodiversity, soil and water comprises:

1. Protected Areas
2. Areas of High Biodiversity
3. Areas of Undisturbed Wildlife
4. Forests
5. Wetlands
6. Degraded Land
7. Land Classification Systems
8. Agricultural Production, Land Use and Environment
9. Soil, Slope and Elevation
10. Water, Hydrology and Climate
11. Concepts for differentiation of spatial information

1. Protected Areas

Database / Product	Reference
World Database on Protected Areas (WDPA)	Strittholt et al. 2007; http://www.unep-wcmc.org/wdpa/index.htm

2. Areas of high biodiversity

Database / Product	Reference
Biodiversity Hotspots	Mittermeier et al. 2005; http://www.biodiversityhotspots.org/Pages/default.aspx
Global 200 – priority ecoregions for global conservation	Olson & Dinerstein 2002; http://www.worldwildlife.org/science/ecoregions/g200.cfm
Important Bird Areas (IBAs)	Stattersfield et al. 1998; Fishpool 2004
Endemic Bird Areas	Birdlife International; http://www.birdlife.org/action/science/endemic_bird_areas/index.html
Important Bird Areas in Germany	Sudfeld et al. 2002

Important Plant Areas (IPAs)	PlantLife; www.plantlife.org.uk/international/plantlife-ipas.html
Centres of Plant Diversity (North, Middle and South America)	WWF & IUCN; http://www.nmnh.si.edu/botany/projects/cpd/
Key Biodiversity Areas	Center for Applied Biodiversity Science (CBS), Conservation International (CI); Langhammer et al. 2007; http://science.conservation.org/portal/server.pt?open=512&objID=421&&PageID=133764&mode=2&in_hi_userid=124186&cached=true
Alliance for Zero Extinction (AZE)	Ricketts et al. 2005; http://www.zeroextinction.org/aze_map.pdf
Gap Analysis Program	http://www.gap.uidaho.edu/default.htm
WWF Wildfinder – Mapping the worlds species	http://www.wwfus.org/wildfinder/index.cfm
Millennium Ecosystem Assessment	http://www.maweb.org , http://wdc.nbii.gov/ma/
High Nature Value Farmland	EEA 2004; http://reports.eea.europa.eu/report_2004_1/en

3. Areas of Undisturbed Wildlife

Database / Product	Reference
Biodiversity Wilderness Areas	Mittermeier et al. (1998)
Global Cultivation Intensity Map (GCIM) from the NASA	http://data.giss.nasa.gov/landuse/cultint.html

4. Forests

Database / Product	Reference
Global	
The Global Land Cover 2000 (GLC2000)	Bartholomé/Belward 2005; http://www-gvm.jrc.it/glc2000/interactive/glc2000_vgt_1280x1024.html
Terra Land Cover	http://edcdaac.usgs.gov/modis/mod12c1v4.asp
Global Forest Resources Assessment (FRA 2000 and FRA 2005)	FAO 2006; http://www.fao.org/forestry/en/ ; http://www.fao.org/forestry/site/fra/en/
Global Observation of Forest and Land Cover Dynamics	http://www.fao.org/gtos/gofc-gold/
Tropical Rain Forest Information Center	http://www.trfic.msu.edu/
Global Forest Watch	http://www.globalforestwatch.org/english/index.htm
Global Forest Fragmentation Data	http://www.srs.fs.usda.gov/4803/landscapes/global-index.html
The world's mangroves	http://www.fao.org/forestry/site/mangrove/en/

National and Regional	
Tropical Rain Forest Information Center (Brazilian Amazon)	http://www.trfic.msu.edu/products/amazon_products/amazonmaps.html
Amazon Forest Inventory Network (RAINFOR, Brazilian Amazon)	http://www.geog.leeds.ac.uk/projects/rainfor/
Natural Resources Canada (NRCAN, Canada)	http://www.nrcan.gc.ca/inter/products_e.html#data
Global Land Cover Facility (Central Africa)	http://glcf.umiacs.umd.edu/data/amazonafrica/
Global Forest Watch (Central Africa)	http://www.globalforestwatch.org/english/interactive.maps/cameroon.htm
Center for International Earth Science Information Network (CIESIN, Central America)	http://www.ciesin.columbia.edu/
The Mesoamerican Regional Visualization and Monitoring System (SERVIR, Central America)	http://servir.nsstc.nasa.gov/lcluc/index.html
European Forest Institute (Europe)	http://dataservice.eea.europa.eu/dataservice/provider.asp?id=1B7DF740-552B-4BFE-97F1-6FFC3B8482A2
European Forest Information Scenario Model (EFISCEN)	http://www.efi.int/projects/efiscen
European Nature Information System (EUNIS, Europe)	http://eunis.eea.europa.eu/index.jsp
Forest Survey of India (India)	http://www.fsiorg.net/forestcovermap.htm ; http://envfor.nic.in/fsi/sfr99/sfr.html
Tropical Rain Forest Information Center (TFRIC, Southeast Asia)	http://www.trfic.msu.edu/products/seasia_products/seasiamaps.html

5. Wetlands

Database / Product	Reference
Global Lakes and Wetlands Database GLWD	Lehner & Döll 2004; http://www.wwfus.org/science/data.cfm
Global Land Cover 2000 (GLC2000)	Bartholomé/Belward 2005; http://www-gvm.jrc.it/glc2000/interactive/glc2000_vgt_1280x1024.html
MODIS Land Cover	http://edcdaac.usgs.gov/modis/mod12c1v4.asp
Hydrological Data Basis	http://www.geo.uni-frankfurt.de/ipg/ag/dl/datensaetze/index.html

6. Degraded Land

Database / Product	Reference
Global Assessment of Soil Degradation (GLASOD)	Oldeman et al. 1991, Oldeman and Van Lynden 2001; International Soil Reference and Information Centre (ISRIC), www.isric.org
South and Southeast Asian Soil Degradation Status Assessment (ASSOD)	www.isric.org
Soil Degradation Assessment in Central and Eastern Europe (SOVEUR)	www.isric.org
Land Degradation in Dry lands (LADA)	http://lada.virtualcentre.org/pagedisplay/display.asp
Global Assessment of Land Degradation and Improvement (GLADA)	www.isric.org

7. Land Classification Systems

Product / Approaches	Reference
Global Land Cover 2000 (GLC2000)	Bartholomé/Belward 2005; http://www-gvm.jrc.it/glc2000/interactive/glc2000_vgt_1280x1024.html
GlobCover Project	http://dup.esrin.esa.it/projects/summary68.asp http://ionia1.esrin.esa.int/index.asp
MODIS Land Cover	http://edcdaac.usgs.gov/modis/mod12c1v4.asp
Human Influence Index (HII)	Sanderson et al. (2002); http://www.wcs.org/sw-high_tech_tools/landscapeecology/humanfootprint ; http://www.wcs.org/humanfootprint
Global Cultivation Intensity Map (GCIM) from the NASA	http://data.giss.nasa.gov/landuse/cultint.html
EarthSat GeoCover Land-Cover	http://www.mdafederal.com/geocover/geocoverlc/gclcoverview
Land Cover Classification System (LCCS)	FAO (2005) http://www.fao.org/DOCREP/003/X0596E/X0596E00.htm
Global Land Cover Characteristics (GLCC)	Olson (1994a, 1994b, cited in Kniivila 2004); http://edcdaac.usgs.gov/glcc/globdoc2_0.asp
Land-Cover and Land-Use Change (LCLUC) Program	NASA; http://lcluc.umd.edu/
Global Earth Observation System of Systems (GEOSS)	http://www.epa.gov/geoss/
CBERS programme	http://www.cbbers.inpe.br/?hl=en

8. Agricultural Production, Land Use and Environment

Database / Product	Reference
Land suitability maps	van Velthuisen et al. (2007) http://www.fao.org/docrep/010/a1075e/a1075e00.htm , http://www.fao.org/ag/agl/agll/cropsuit.asp
Agro-MAPS: Global Spatial Database of Agricultural Land-use Statistics	http://www.fao.org/landandwater/agll/agromaps/interactive/page.jsp
Land Use Systems database of the world	FAO-Beta version (on request available from Freddy Nachtergaele)
Agro-MAPS – Mapping of Agricultural Production Systems	http://www.ifpri.org/data/g_s_agromaps.htm

9. Soil, Slope and Elevation

Concepts / Database	Reference
Harmonized World Soil Database (HWSA)	http://www.iiasa.ac.at/Research/LUC/luc07/External-World-soil-database/HTML/index.html ; FAO/IIASA/ISRIC/ISS-CAS/JRC (2008)
Digital Soil Map of the World	http://www.fao.org/ag/agl/agll/dsmw.htm
World Reference Base for Soil Resources	http://www.fao.org/ag/agl/agll/wrb/default.stm
Global Soil and Terrain Databases (WORLD-SOTER)	See overview in FAO/IIASA/ISRIC/ISS-CAS/JRC (2008); http://www.fao.org/ag/agl/agll/soter.stm
The European Soil Database	See overview in FAO/IIASA/ISRIC/ISS-CAS/JRC (2008); http://eusoils.jrc.it/
The Soil Map of China 1:1 Million scale	See overview in FAO/IIASA/ISRIC/ISS-CAS/JRC (2008)
U.S. General Soil Map (STATSGO2)	http://www.soils.usda.gov/survey/geography/statsgo/
The National Soil DataBase (NSDB), Canada	http://sis.agr.gc.ca/cansis/nsdb/
Australian Soil Resource Information System (ASRIS)	http://www.asris.csiro.au/index_other.html
Problem Soils Database (ProSoil)	http://www.fao.org/AG/AGL/agll/prosoil/default.htm
ISRIC – World Soil Information	http://www.isric.org/

International Union of Soil Sciences (IUSS)	http://www.iuss.org/
HWSD Supplementary Data – Global Terrain Slope and Aspect Data	http://www.iiasa.ac.at/Research/LUC/luc07/External-World-soil-database/HTML/global-terrain-slope-download.html?sb=7
Elevation model (worldwide) – NASA's Shuttle Radar Topography Mission (SRTM))	http://www2.jpl.nasa.gov/srtm/

10. Water, Hydrology and Climate

Concepts / Database	Reference
WaterGAP (Water - Global Assessment and Prognosis)	http://www.usf.uni-kassel.de/watclim/pdf/watergap_model.pdf
UNESCO International Hydrological Programme	http://typo38.unesco.org/en/themes/global-changes-and-water-resources.html
Digital global map of irrigation areas	http://www.geo.uni-frankfurt.de/ipg/ag/dl/datensaetze/1_irrigation_map/index.html
Digital global map of artificially drained agricultural areas	http://www.geo.uni-frankfurt.de/ipg/ag/dl/datensaetze/2_agricultural_drainage_map/index.html
Global drainage direction map	http://www.geo.uni-frankfurt.de/ipg/ag/dl/datensaetze/3_drainage_direction_map/index.html
Global lakes and wetlands database	http://www.geo.uni-frankfurt.de/ipg/ag/dl/datensaetze/4_lakes_and_wetlands/index.html
HydroSHEDS (Hydrological data and maps based on Shuttle Elevation Derivatives at multiple Scales)	http://hydrosheds.cr.usgs.gov/
AQUASTAT – main country database	http://www.fao.org/nr/water/aquastat/dbase/index.stm
AQUASTAT – global maps	http://www.fao.org/nr/water/aquastat/globalmaps/index.stm
AQUASTAT – Climate Information Tool	http://www.fao.org/nr/water/aquastat/gis/index3.stm
CROPWAT	http://www.fao.org/nr/water/infores_databases_cropwat.html ftp://ext-ftp.fao.org/AG/Data/agl/aglw/Cropwat
AQUACROP	http://www.fao.org/clim/docs/CDROM/docs/Nairobi/MethodsTools01Jun07.pdf
Global Terrestrial Observation System (GTOS) – River Discharge, Water Use, Ground Water, Lake Levels	http://www.fao.org/gtos/index.html http://www.fao.org/gtos/ECV-T01.html

11. Concepts for differentiation of spatial information

Concepts / Database	Reference
Ecoregions	Olson et al. 2001; http://www.worldwildlife.org/science/ecoregions/biomes.cfm
Agro-ecological Zoning (AEZ), Global Agro-ecological Zoning (GAZE)	Fischer et al. (2000), FAO (2005); http://www.fao.org/ag/agl/agll/prtaez.stm http://www.geo.ucl.ac.be/LUCC/lucc.html

6 Appendix 2 – Literature to be considered (not exclusively)

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