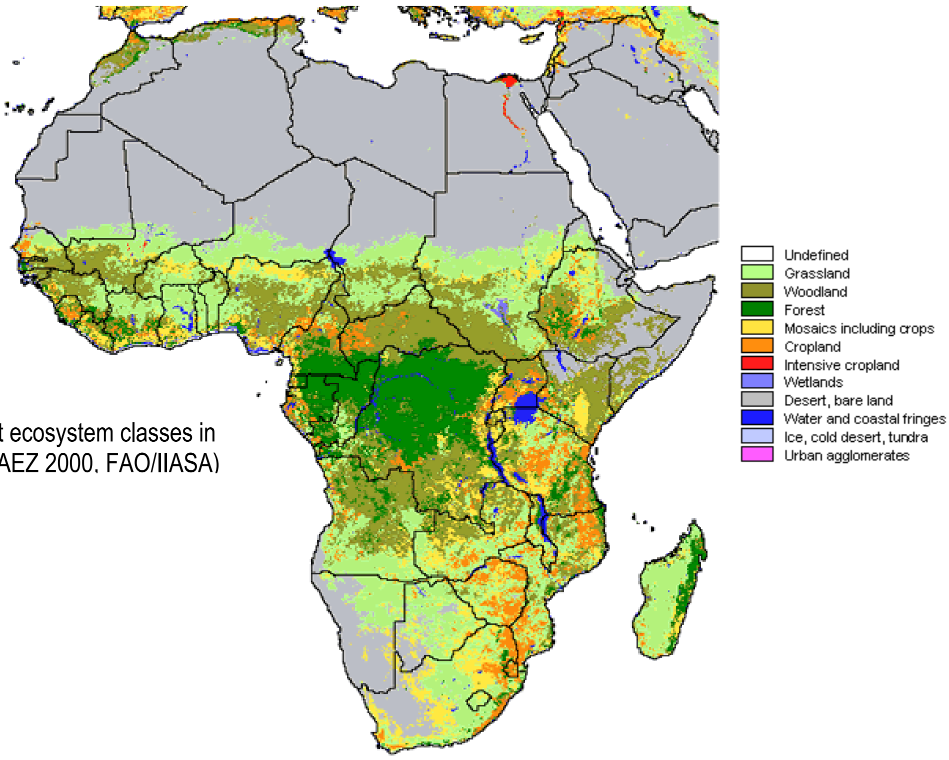
Technical Report No. 5

DEFINITION OF SOCIOECONOMIC SCENARIOS FOR LAND SURFACE HYDROLOGY SIMULATIONS OF THE 21ST CENTURY



Dominant ecosystem classes in Africa (GAEZ 2000, FAO/IIASA)

Author names: Dieter Gerten, Ingjerd Haddeland, Stefan Hagemann, Fulco Ludwig, David Wiberg, Frank Voss

Date: 20 August 2008

WATCH is an Integrated Project Funded by the European Commission under the Sixth Framework Programme, Global Change and Ecosystems Thematic Priority Area (contract number: 036946).
The WACH project started 01/02/2007 and will continue for 4 years.

Title:	Definition of socioeconomic scenarios for land surface hydrology simulations of the 21st century
Authors:	Dieter Gerten, Ingjerd Haddeland, Stefan Hagemann, Fulco Ludwig, David Wiberg, Frank Voss
Organisations:	PIK, MPI-M, WUR, IIASA, CESR
Submission date:	20 August 2008
Function:	This report is an output from WB 3 (generated together with WB 2 and WB 6), Task 3.3.1
Deliverable	WATCH deliverable 3.3.1

This deliverable reports on discussions and progress made to define scenarios for the 21st century that reflect regional and global changes in socio-economic conditions (basically land and water use), which shall be used to prescribe temporal, and spatially distributed, boundary conditions for the later global and regional hydrological sensitivity simulations.

These input databases shall be used for several purposes, a) for specific analyses by individual WATCH members and models, and b) for the planned intercomparison of hydrological and land surface models for the 21st century. The present, preliminary overview of available data should be regarded as a starting point. The final set of scenarios/boundary conditions to be used and the list of models that are to participate in the 21st century runs will have to be decided upon by the model intercomparison consortium in a later stage of the WATCH project, probably during the General Assembly in November 2009 in Bratislava.

It will be ensured that the eventually chosen socioeconomic scenarios are consistent with the GCM projections of climatic changes that they underlie, i.e. those stemming from the SRES 'family', preferably the conveniently used A2 and B1 emissions scenarios (or the moderate A1B scenario if only one scenario is chosen). For particular (probability-based) applications by single models, a much larger set of scenarios can be chosen.

For WB2, IIASA has produced a suite of historic and SRES-consistent future databases (not yet in netCDF format), which are recommended for use in the later hydrological simulations in WATCH (within WBs 3, 4, 5, and 6). A link to these global databases and more detailed descriptions are available upon request from David Wiberg, wiberg@iiasa.ac.at; in the following only a short description of the data sources is provided.

a) Historic land use (cropland and pasture area in km^2 per grid cell), taken from the HYDE database (e.g. Klein Goldewijk 2001) and provided as decadal values for the years 1900 to 2000 (which can be interpolated linearly to annual values).

b) Historic population data in the same resolution also taken from HYDE (Klein Goldewijk 2005), namely population counts and densities, i.e. number of inhabitants per grid cell (distinguished between rural and urban) and inhabitants per km^2 per grid cell.

c) Current land use and land cover including seven major land cover/land use categories at 5 min resolution (GAEZ, Fischer et al. 2008), as follows: 1) The GLC2000 land cover database at 30 min resolution; 2) a global land cover categorization providing 17 land cover classes at 30 min, based on IFPRI (2002); 3) The FAO (2001) Global Forest Resources Assessment at 30 min; 4) The Digital Global Map of Irrigated Areas (GMIA) version 4.0 at 5 min, providing per grid-cell the percentage land area equipped for irrigation (Siebert et al. 2005); 5) IUCN-WCMC protected areas inventory at 30 min (http://www.unep-wcmc.org/wdpa/); and 6) a spatial population density inventory (30 min) for 2000 developed by FAO-SDRN. These data distinguish between fractional coverage by different types of land use. Downscaled data on areas of individual crops are being worked on; areas suitable for different crops are already available.

d) Spatially explicit scenarios of **future** land use, population, GDP (gross domestic product) and energy, describing three alternative demographic-economic development scenarios over the period 1990 to 2100 in decadal intervals at 30 min resolution. The three latter products include gridded values of 1) population counts, 2) population densities, 3) GDP at market exchange rates (US$1990), and 4) densities of the latter (1000 US$1990) (Grübler et al. 2008; data accessible at http://www.iiasa.ac.at/Research/GGI/DB/). New SRES-consistent future land use datasets are being created, which provide percentage values of land cover at 5 min resolution for the following classes: cultivated rainfed land, cultivated irrigated land, total cultivated land, forested land, grassland, urban areas, water bodies, and others (sparsely vegetated land). At the time of writing this report, one land use scenario (based on the storyline of one of the SRES scenarios) is completed, others are expected to be completed within the next months. In addition to these data, suitability classes for different agricultural crops and pasture in the 21st century can be provided.

Yet, there is still some inconsistency between the (IIASA-based) land use data available for the past and those available for the future. If for the hydrological simulations consistency is required, continuous databases from 1900 to 2100 may be produced at the cost of significantly reduced data quality.

Data from other groups are likely to be used in addition for particular analyses by individual modelling groups in different WBs. These may include, for example, the SRES-consistent land use datasets created by the IMAGE group, which would allow for a comparison of the hydrological effects of the differences between that product and the IIASA data; or the SRES-consistent population data from Bengtsson et al. (2007). In addition, further scenario data will be required for individual studies on future water availability and stress, in particular scenario data on water use by different sectors (water use by households and industries e.g. as described by Shen et al. (2008), and also water use in irrigation if this is not computed directly by the models).

References

Bengtsson, M., Shen, Y., Oki, T. (2007) A SRES-based gridded global population dataset for 1990–2100. *Population & Environment* 28, 113–131.

FAO (2001) Global Forest Resources Assessment 2000: Main report. *FAO Forestry Paper* 140, Rome.

Fischer, G., van Velthuizen, H., Shah, M., Nachtergaele, F. (2002) *Global Agro-Ecological Zones Assessment for Agriculture in the 21st Century: Methodology and Results. IIASA, Laxenburg, Austria.* IIASA/FAO.

Grübler, A. B. O'Neilla, B., Riahia, K., Chirkova, V., Goujona, A., Kolpa, P., Prommera, I., Scherbova,S. Slentoe, E. (2008) Regional, national, and spatially explicit scenarios of demographic and economic change based on SRES. *Technological Forecasting & Social Change* 74, 980-1029

IFPRI (2002) *Reinterpretation of global land cover characteristics database (GLCCD v2.0, EROS Data Center)*, unpublished dataset. Washington D.C.

JRC (2004) *Global Land Cover (GLC) 2000 Database, 1st ed.* European Commission Joint Research Center (JRC) Global Environment Monitoring Unit.

Klein Goldewijk, K. (2001) Estimating global land use change over the past 300 years: the HYDE database. *Global Biogeochemical Cycles* 15, 417–434.

Klein Goldewijk, K. (2005) Three centuries of global population growth: A spatial referenced population density database for 1700 – 2000, *Population & Environment* 26, 343–367.

Shen, Y., Oki, T., Utsumi, N., Kanae, S., Hanasaki, N. (2008) Projection of future world water resources under SRES scenarios: water withdrawal. *Hydrological Sciences Journal* 53, 11–33.

Siebert, S., Döll, P., Hoogeveen, J., Faurès, J-M., Frenken, K., Feick, S. 2005. Development and validation of the global map of irrigation areas. *Hydrology and Earth System Sciences* 9, 535–547.