Session 3c: Infrastructure spatial and temporal detail linking to energy-land-water nexus

Global modelling of water availability and water use under current conditions and future scenarios

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The quantity and quality of the world's freshwater resources are increasingly under pressure. Water use – for drinking, irrigation, industry, energy production and environment - has almost tripled over the past 50 years and is expected to continue to grow substantially over the next 50 years. In many countries, current levels of water use are unsustainable and both periodic and chronic shortfalls of water may be exacerbated by population growth, land use changes (e.g. urbanisation, food and biofuel production, water resource developments), economic activity and intensifying competition among water users, as well as climate change. This situation is compounded by uncoordinated development and management, especially in transboundary river basins where local and national priorities may conflict with basin-wide concerns. The requirement for society to manage water resources in an integrated and sustainable manner and reduce its vulnerability to change has become a driving force behind the use of macro-scale modelling approaches to understand the potential impacts on water resources of future changes.

There is a great diversity of modelling approaches, developed in response to differing requirements in terms of purpose, scales, data availability, computing power, etc. Gridded models applied across large areas, normally the global, continental or regional scale, at a resolution typically of the order of 0.1^{o} or 0.5^{o} lat/long, may be grouped into two main classes:

- Land Surface Hydrology Models – originating from the land surface descriptions within climate models, these have strong process representation to simulate the vertical exchanges of heat, water and carbon, but are weak on lateral transfers of water.
- Global Hydrological Models – have a good representation of lateral transfers of water, generating river flow from conceptual rainfall-runoff models driven by precipitation, evaporation and temperature data, but are weak in energy, water and carbon linkages.

The incorporation of water use components within global hydrological models enables the natural system, with its critical importance for resource quantity and quality, to be integrated with the human system, which determines resource use and waste production. While many regions of the world are data-sparse, global hydrological models have benefitted from the ever increasing availability of global datasets of land surface descriptions (e.g. land cover, geology, soils, etc) and meteorological driving data. Hence, global hydrological models form a key tool for the assessment of impacts by providing insights into the inter-relationships between climate, water and the anthropogenic pressures upon water resources in a consistent and spatially-coherent manner.

The presentation uses applications of the GWAVA global hydrological model to illustrate the value of such modelling approaches in generating realistic assessments of water availability in comparison to water demand, taking into account environmental and socio-economic factors. GWAVA (Global Water Availability Assessment) was developed in the 1990s and originally applied to data-challenged eastern and southern Africa. Over the past 20 years it has been improved and applied globally under the EU FP6 WATCH (Water and Global Change) programme, as well as to a range of river basins, countries, regions and continents, to provide unique insights into the critical impacts of different combinations of climate, population and land use drivers. As such, it implicitly recognises the linkages between water resources and food and energy production.