As the evidence for human induced climate change becomes clearer, so too does the realization that its effects will have impacts on socio-economic systems and terrestrial ecosystems. Some regions are more vulnerable than others, both to expected physical changes and to the consequences they will have for ways of life. Mountains are recognized as particularly sensitive physical environments with populations whose histories and current social positions often strain their capacity to accommodate intense and rapid changes to their resource base.

This proposal aims to assess the impacts of a changing climate, focusing on the quantity and quality of water originating in mountain regions, particularly where snow- and ice melt represent a large, sometimes the largest, streamflow component. There, they represent a local resource (freshwater supply, hydropower generation, irrigation), but in most cases also considerably influence the runoff regime of the downstream rivers and the related water availability. Such an influence is reflected mainly in the amount of surface water available for supplying irrigated agriculture and water supply systems, but also in the amount of groundwater recharge that can take place in river–fed aquifers. An increasing number of evidences of glacier retreats, permafrost reduction and snowfall decrease have been observed in many mountainous regions, thus suggesting that climate modifications may seriously affect streamflow regimes, in turn threatening the availability of water resources, increasing the downstream landslide and flood risk, impacting hydropower generation, agriculture, forestry, tourism and, last but not least the water dependent ecosystems. As a consequence, socio-economic structures of downstream living population will be also impacted, calling for better preparedness in developed countries and strategies to avoid the exacerbation of the already conflictual situation in many developing countries, like those in Central Asia and South America.

The goal of the project is to use advanced modelling techniques to quantify the influence of climatic change on the major determinants of river discharge at various time and space scales, and analyse their impact on society and economy, also accounting for feedback mechanisms. The focus will be on continuous transient scenarios from the 1960s up to 2050. In comparison to many existing studies, the limitation of the modelling horizon to mid of the 21st century allows to develop more realistic assessment of the progressive impact on the social, economical and political systems, which we expect to evolve typically in an adaptive mode on shorter time scales than the centennial ones, eventually shifting to new equilibria when forced abruptly.

The data required for the multiple model applications will be managed in the form of a “data warehouse” that will begin collecting and centralizing the data for the entire ACQWA community from the start of the project. The specification of data and the data formats will be defined in collaboration with the partners within the first 2-5 months of the project, and by the end of the first year, data will be available through the Internet for use in the different Work Packages. Additional data, such as remotesensing information, will be ready by the end of the second year, while the socioeconomic data required for many of the non-physical impacts studies will be brought online from the inception of ACQWA through to the end of the project. The data warehouse will be continuously updated and maintained for the entire duration of the project.

Regional climate models will provide the essential information on shifting precipitation and temperature patterns, and snow, ice, and biosphere models will feed into a hydrological model in order to assess the changes in basin hydrology and seasonality, amount, and incidence of extreme events in various catchment areas. The type of extremes that will be analyzed here include certain weather patterns that result in exceptional flooding (e.g., storms of Mediterranean origin: see Subtask 3.4.2, in particular), and geomorphologic hazards. These include various forms of erosion and slope instabilities that often end up in rivers, contributing to increased sediment loading and lead to potential problems for infrastructure close to the rivers or hydropower installations (see Subtask 3.4.3 later on in this document). One consortium partner (Subtask 3.4.1) will be developing appropriate analysis methodologies to address the impacts on watersheds of extremes of temperature, storm rainfall intensities, peak flows, and dry spells.

Essential regional climate model data will already be available within the first year of the project, while by Month 24, there will be fine-scale information based on downscaling techniques for use in regional/local impacts studies. While this data at fine spatial and temporal scales is being prepared, work on refining process-oriented models (hydrological, cryospheric, and biospheric models) will be undertaken so as to be in an optimal state of readiness by Month 24. As the project evolves, new data will be updated and will be made available through to the end of the funding period. Many of the models applied here require developments, updating and refinements that will depend not only on the availability of data but also on the intensity of the links between sub-components of the project (as shown later in Table B1.3f).

Most of these process-oriented models will begin work from the very early stages of ACQWA or at the latest in the second year, and while many results are expected by the end of Month 48, some of the more resource-intensive modelling (climate and hydrological applications) will be conducted through to the end of the project. Environmental and socio-economic responses to changes in hydrological regimes will be analyzed in terms of hazards, aquatic ecosystems, hydropower, tourism, agriculture, and the health implications of changing water quality. Attention will also be devoted to the interactions between land use/land cover changes, and changing or conflicting water resource demands. Integration of the information from all these sectors and the impacts on economies will feed into a quantitative model of water use incorporating supply and demand.

Supply is conceived as having physical inputs (from the regional climate models) as well as societal inputs based on property, price, and regulatory factors. Demand reflects population evolution, price, and economic activity. Components of the ACQWA project focusing on elements such as hydropower, tourism, or aquatic ecosystems will start little later in the project. This will enable the partners involved in these issues to be able to access the ACQWA databases (see ACQWA Data Warehouse under Work Package 2) that will be built up in the first year of the Project, and therefore to have the most up-to-date information for implementing their research. This delay in time should not exceed 12 months, however, in order for the work to be completed well ahead of the end of the project, in order for the research results to be appropriately disseminated and translated into policy terms. As shown in the table under B1.3.2, most of the tasks and subtasks beginning in Month 12 or later will be completed by Month 48, and any work done in the final year will be towards the final report, policy recommendations, and wherever appropriate, transposition of the methodologies to other regions.