

## **Annex G: Environmental impact assessment**

### **WORK PACKAGE 3: ENVIRONMENTAL IMPACTS AND TRADEOFFS**

#### **Identification, delineation and description of wetland areas:**

Remote sensed imagery and field observation will be used to identify, describe and classify wetlands in the selected study areas following the methods described in Work Package 1 (mapping Spatial Extent of SGI) and outlined in Finlayson et al (1998), Genfell et al 2005, and Gordon et al (2000). The methods used for delineation will follow those of Gilbert et al. (2006), Marnewecke & Kotze (1999) (see Figs 1 – 2) and Smith and Klimas (2002). Marnewecke & Kotze (1999) note that their "framework for the cost-effective delineation of wetlands was developed so as to minimize the lengthy collection of data by specialists. The possibility of using local people living in the SGI areas as field assistants, as a way of involving them in project activities could be important for project acceptance.

#### **Assessment of the impact of SGI on natural wetlands:**

“Generic” wetland assessment methods, designed to assess multiple types of wetlands, lack the level of detail necessary to detect significant changes in function. Consequently, one way to achieve an appropriate level of resolution rapidly is focus on a subset of wetlands, thereby reducing the level of variability exhibited by the wetlands being considered. The Hydro-Geo-Morphic (HGM) classification was developed specifically to accomplish this task. It identifies groups of wetlands that function similarly using the criteria of geomorphic setting, water source, and hydrodynamics. The methodological assumptions in the HGM approach used by Bradley (2005) are consistent with the SGI study, i.e., that cumulative impacts on wetlands cause degradation of environmental quality and ecological integrity, and the cumulative effects of these impacts depend on the functional wetland type impacted and alteration of land cover and land use results in loss and functional conversion of wetlands.

#### **Estimation of the trade-offs between ecosystem functions and services of wetlands and SGI areas:**

The VINVAL project has developed methods for rapid diagnostic appraisal for agricultural and natural systems in Ghana which give semi-quantitative results (Meijerink, 2003). The methods selected were to assess the economic importance of the tradeoffs and complementarities between natural and agricultural ecosystems and the different functions they provide. As a proven method, it is proposed that their system of Semi-Structured Interviews (SSI) would be used for this study: a guided interview is based on predetermined topics but new questions are posed in response to challenging or unusual answers from respondents, which usually lead to rich detail and insight.

#### **Estimation of reference baseflows and groundwater storages**

SGI impacts the local groundwater regime within the farmed system as well as in downstream ecosystems, reducing baseflow – part of the total streamflow supplied by SG storage. The time series of baseflow and groundwater storage will be required to study the above impacts and environmental implications. A digital filtering technique (Smakhtin,

2001) will be applied to observed or generated streamflow time series at sites, impacted by SGI, to produce continuous baseflow hydrographs. Groundwater storage time series may then be estimated using the principle of a linear reservoir, which assumes that storage is proportional to outflow (baseflow). Estimates of groundwater recharge may be obtained as the difference between the current storage and the storage remaining from the previous month. Both time series will be calculated for reference conditions, against which to assess the SGI impacts. The total streamflow time series will be estimated by methods of hydrological regionalization, e.g. by transferring available observed unimpacted flow time series from a hydrologically similar catchment to selected sites (e.g. Hughes and Smakhtin, 1996).

### **Estimation of the environmentally acceptable baseflow and groundwater storage**

Similar steps will be performed when ecologically acceptable flow time series (Environmental Flows- EF) are used instead of reference natural flow time series. The EF time series will be estimated using the methodologies already developed at IWMI and tested in Nepal, Sri Lanka and India ( Smakhtin et al. 2006; Smakhtin and Anputhas 2006). These methods allow setting the environmental objectives and flows necessary to achieve them. The most important ecological issues downstream of the SGI-induced impacts and formulation of environmental management objectives for impacted streams are established through a field visit. Local ecological expertise will be imperative in this regard. Once the environmental objectives are set, a corresponding time series of EF can be calculated. Ecologically acceptable baseflow time series is then calculated from the EF time series using digital filtering technique. A corresponding groundwater storage time series is determined using linear reservoir principle. This time series represents the acceptable limits of groundwater use. Such storages may provisionally be called “EF driven”. EF and EF-driven storages are therefore dependent: EF determine groundwater storages necessary to maintain them. The difference between reference and “EF driven” storages represents exploitable groundwater. The differences between present-day “EF driven” storages represents the remaining exploitable SG. If the latter time series is negative – continuously or occasionally - it is indicative of the over-exploitation. The historical and current groundwater storages may also be compared with reference and “environmentally acceptable” storages to illustrate the impacts of SGI.

### **Extrapolation to the entire White Volta Basin**

The above methodology allows the assessment of ‘environmentally safe’ utilizable portion of SG resources to be made at the scale of one or two test sub-watersheds. The Work Package 1 will attempt, on the other hand, to produce a basin-wide map of areas, which are subject to SGI now and in the future. It will therefore be possible to extrapolate the estimates of utilizable SG in test basins, to the entire White Volta Basin, although in a crude way. The extrapolation can be done through a combined analysis of SGI potential and hydrogeology maps. This will allow the extent of current SGI use, remaining utilizable SG resources and anticipated time horizon for full development of SGI potential to be estimated.