



Land-Water Linkages in Rural Watersheds Electronic Workshop

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Case Study 2

Inter-relationships between agriculture and hydrology in lowland areas. Case of the Kangura Watershed, Burkina Faso

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PROBLEMATICS

Since the great drought of the years 1970-1980s, the climatic pejouration and the growing demographic pressure have negative consequences on agriculture in western African countries. The land pressure on arable areas has highly increased, leading to problems of over-exploitation and thus soil degradation (erosion, loss of fertility). Risks of disturbing agronomic cycles have also increased for some crops.

These new constraints enhanced the interest of rural communities in cultivating lowland areas, whereas hillslope areas were traditionally preferred (Albergel et al, 1993). Lowlands are flat or concave zones located in main valleys and are generally less than 100 ha wide. They drain water from surrounding hillslope regions and store it in the ground or by submersion. The whole surface of lowlands in sub-saharan Africa is approximately estimated to 1.3 million km², which corresponds to 5% of the arable lands. Thus these zones are interesting agricultural land resources providing that hydrometeorological hazards, which are sources of water resources inter and intra-season high variability, are efficiently managed. Since the 1980s, the generally adopted solution is based on hydraulic projects of the lowland itself, at the scale of the village and as much as possible with the local population participating in the financing and the technical management (Lidon *et al.*, 1998).

But questions and problems are today pointed out. Indeed, hydraulic projects themselves are not always well adapted to the physical environment, neither managed on optimized basis. Moreover such projects have downstream consequences and building them in series can generate negative domino effects (Daurensan, 1997). Consequently, we need a better observation and understanding of the hydrological functioning of the lowland as a part of the whole catchment; a risk evaluation in terms of agricultural development; and an estimation of anthropic impact. For these reasons, we study the Kangura watershed, western Burkina Faso.

THE KANGURA WATERSHED

At the 254300 / 1163800 UTM coordinates outlet, the watershed is 1.1 km² large. It is presented on Figure 1, from aerial photograph and geographical information system analysis.

On the climatic point of view the watershed is located in the Soudan-Guinean zone, with an average annual rainfall height superior to 1000 mm and the rainfall season running from June to October. Concerning the geology, it takes place on the old peneplane of the western African massif.

In agricultural terms, the watershed is cultivated both for food-producing and to-be-sold crops. Lowland areas are actually strongly settled and the sub-watershed 1 should be modified by a structural hydraulic project within few years. The anthropic pressure is increasing and should be precisely studied.

IMPLEMENTATION OF A PILOTE EXPERIMENTAL RESEARCH SITE

Our first purpose is to proceed to a precise experimental observation of the watershed, based on a dense sensors network. This network is actually being implemented (Sinaré, 2000). First of all, it will consist in about six raingauges and short pace-time rain-recorders, allowing to deal with the rainfall input space and time variability. In order to observe surface flows, few gauging stations are now being built and calibrated. We consider two types of measurement sites: those located at places where the stream enters into the lowland area, which should describe flows under the only influence of surrounding hillslope area processes; and those located in the lowland stream itself under groundwater and submersion influence. At last, many piezometric

transects and a precise topographic mapping should allow to follow ground and inundation dynamics.

This experimental network, combined with a geographic diagnosis (geomorphology, agricultural practices) should lead to a good understanding of the functional relationship which exists between surrounding hillslopes and lowlands, and inside of lowlands themselves between stream, overland and ground waters. Especially we will study these different dynamics in terms of non-linearities, characteristic scales and feedback effects.

On the base of this experimental observation and understanding of hydrological dynamics, our second purpose is to develop a physically-based modelling of lowland functioning. Limit conditions of this model will be transfers from and to the atmosphere, multi-flow drainage of hillslopes, deep percolation and

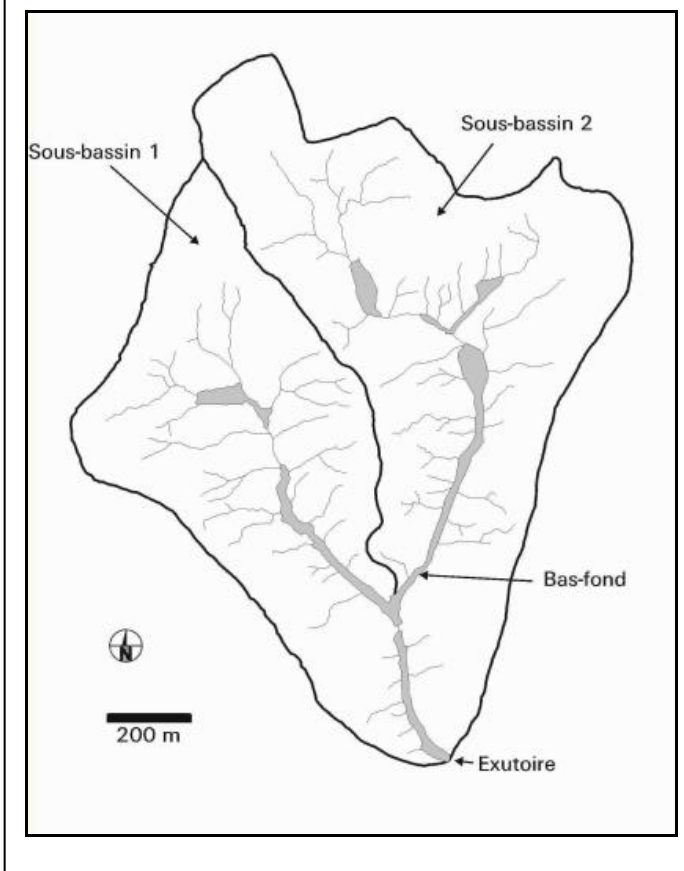
flow at the outlet. The key point is thus the identification of main processes for each geomorphological entity, in order to break the particularly complex whole system into much less complex sub-systems (Cudennec, 2000). Results of such a modelling have to be relevant informations for local hydraulic engineering and agriculture stakeholders, at the event scale, such as: flow estimations at different locations; water quantity stored in different geomorphological entities; groundwater depth; submersion extension, duration and height.

Finally, our third purpose is to develop decision support on a longer time scale, from the understanding of processes and the event analytical modelling. Indeed this modelling should help in deducing statistical informations on water resources for agriculture from climatic studies, and thus risks of loosing crops. Moreover physically-based modelling allows to simulate scenarios of hillslopes and lowland anthropic modification, even projects in series on a single stream through different village territories and strategies. This kind of prospective modelling should be a relevant tool for integrated watershed management and the project which is on the way for the sub-catchment 1 of our study site is an interesting context for working on this problematics.

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FIGURE 1
The Kangura catchment



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