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PREFACE

New Challenges and Old Opportunities of Water-related Food Security

Livelihood Risks and Planning Challenges

With climate change, the frequency of extreme events and periods is supposed to increase and become more pronounced. The existing approach to storage and regulation may no longer be considered sufficient to cushion against the extremes, i.e. to store and regulate excess water between periods of plenty and scarcity. Whereas water resources data are often given in terms of averages, the reality is characterized by a high degree of variability and unpredictability. Rainfall patterns typically vary over relatively short distances in a basin and over time. Seasonal variation is a major risk factor for farmers and fluctuations from one year to another also pose challenges to planners in terms of the dimensioning of structures for storage and conveyance. The short-term highly stochastic variations are often combined with semi-cyclical periods of wet and dry periods of a few years. A one-year below-average rainfall may not be disastrous, but when several years of below-average rainfall occur, a drought situation with serious socioeconomic consequences has developed.

The five articles that follow originate from a seminar during the World Water Week in Stockholm, Sweden, in August 2009, around the issue 'Rainfall variability is more significant than climate change?'. The aim was to elucidate the significance of rainfall variability and unpredictability and to suggest approaches to document and deal with the challenges involved.

There Is No Such Thing as an Average

In the first article, Faures *et al.* stress that managing uncertainty related to climate variability has always been at the core of all agricultural activities. For farmers across the world, the concept of average rainfall is often less important than its dispersion and distribution during the cropping season. Farming practices are based on risk-mitigation strategies that do not allow for the development of highly productive agriculture, but mitigate the risks associated with the variability of climate and of other factors like markets or freshwater availability.

The article reviews the concept of average precipitation and discusses the stochastic nature of climate variables. It addresses the relationship between climate and crop production and related farmers' behaviour, and discusses the different tools and approaches

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that are available to anticipate, mitigate or compensate for the negative effects of climate variability in agricultural production.

The article concludes that variability of weather has always been, and probably still remains, one of the most significant constraints to farming, in particular in semi-arid and sub-humid regions, and a substantial restriction to increased crop productivity. A range of 'hard' and 'soft' options exist to compensate for the negative effects of rainfall variability in agriculture, but many developing countries do not have the necessary infrastructure and institutional environment that are required to manage such risk. For millions of farmers in developing countries, there is no such thing as average rainfall or stable market prices, and the burden on their livelihood is often excessive. Probably the most effective agricultural policies are those that help manage the risk of crop failure and maintain predictable price levels. By increasing uncertainty, climate change will only add a new dimension to a very old challenge.

Coping with Rainfall Variability

In the second article, Barron *et al.* analyse short-term rainfall variability. To increase both on- and off-farm biomass production and productivity with these climate-induced temporal and spatial variations of water is challenging. In the Sahel there are, however, patches and areas of 'greenness' on-farm and in the landscape that have developed as a result of tree planting, agro-forestry and crop productivity improvements over the last 25 years.

The authors do not find any impact from these improved systems on landscape water balances. Local rainfall data together with field data on tree cover and farming system practises were collected at two villages east of Maradi, south-east Niger, to estimate dry spell occurrence. A semi-distributed hydrological and crop growth model (ArcSWAT) was run for four production alternatives: conventional or fertilized combined with millet crop or millet crop plus trees, to assess long-term yield and implications for landscape water balance. The authors show that inherent dry spells are a reality with severe implications for smallholder agro-ecosystems in semi-arid Sahel.

The authors conclude that water managers must be more innovative when identifying opportunities to improve water productivity. To assist smallholder farmers further to enhance their current low-yielding production in dry-spell-affected areas, managing water availability for crops is essential. Improving nutrient status by access to fertilizers is, however, equally essential. Also, increasing tree cover in a water-conscious manner may be beneficial, with species valuable for farmers and suitable for the eco-region. The policy opportunities are therefore complex. Proposed adaptation measures for smallholder farming systems in these environments are in fact very much the same as those proposed to enhance local production and incomes in a climate change context. At minimum, they require access to affordable fertilizers, knowledge among farmers of how to use them, improved access and knowledge of tree management in landscapes, and local and national legislation to support the use of fertilizers and planting of trees.

Australia Demonstrates the Planet's Future

In the third article, Pittock and Connell analyse fluctuating water availability in Australia's rivers, which are among the most variable in the world. In the Murray–Darling

Basin (MDB), water management has focused on increasing agricultural production while reducing risks from the fluctuating resource.

The article shows that pressure for development and over-optimistic assessments of available water have resulted in over-allocation and increasing ecological decline. This decline has been severely exacerbated by a record-breaking drought, severely challenging the management of water resources. In recent years, governments have agreed to radical policies such as the National Water Initiative 2004 and allocated substantial funds to back up policy. As the socioeconomic implications have become clearer, implementation is in gridlock, however. A draft MDB Basin Plan, due for release in mid-2010 before finalization in 2011, will be the first basin-wide plan and it is intended to deal with inequities across state borders and risks such as climate change and drought. The current (2002 +) drought with inflows of water into the river reduced by 70% is more severe than even the 'extreme dry' climate-change scenario. The article shows that contradictory policies are hindering the more open adaptation required to manage a drier future.

The article concludes that although the current water-scarcity crisis in the basin has been the impetus for further institutional reform, this reform is slow and contains substantial compromises. Although good management of drought would position Australia well to manage anticipated climate change, past performance has shown that overcoming the legacy of the past, not least the cultural and management bequest, is in fact a formidable challenge. The authors stress that Australia may offer lessons for management of water variability and change in Mediterranean climates, as well as in other federated states.

Droughts in a Tropical Environment

In the fourth article, Adamson and Bird discuss the notion of drought as a hydro-meteorological hazard in tropical monsoon regions. In view of the term 'monsoon' being commonly regarded as synonymous with torrential rainfall, moisture surplus, floods and climatic predictability, droughts may not fit naturally with conventional perceptions. The article also draws distinctions between different aspects of drought: meteorological, agricultural, hydrological and socioeconomic.

The article first reviews recent historical events within the Lower Mekong Basin. There, a weak monsoon results in deficient flows and water levels that can have severe impacts upon agricultural production across the Cambodian flood plain and the delta in Viet Nam, where natural and controlled inundation is the basis of padi rice production. Lower flows also cause an increase in saline intrusion in the delta, which further reduces agricultural output. The article then examines Thailand and Lao PDR higher upstream, revealing the impacts of an early end to monsoon conditions on agriculture. Variability from season to season is considerable, as is the spatial variability of flood or drought occurrence, with a clear line of discontinuity between upper and lower parts of the basin. The authors emphasize the potential negative consequences of climate change which are expected to result not only in the increased inter-annual variability of regional rainfall, but also in impacts upon its seasonal pattern and timing.

The authors conclude that, contrary to popular opinion, a tropical climate environment such as the Mekong Basin can be subject to extremes of drought with real consequences for agricultural production and the livelihoods of millions of people. Building drought-management capacity is therefore important through a climate change and adaptation

initiative that includes forecasting, impact assessment, and the development of management, preparedness and mitigation policies. The current emphasis on climate change and adaptation may in fact also provide the necessary impetus to address the previous underinvestment in regional, national, and local capacities for drought management and mitigation.

Adaptation to Rainfall Variability and Unpredictability

The final article by Lundqvist and Falkenmark addresses variation and unpredictability in water availability at different geographical and time scales. These authors highlight differences between water fluxes at basin scale and water in the root zone. In both cases, land management is a determining factor for the characteristics of water resources. Together with soil quality and characteristics, the co-management of land and water dictates the conditions for farming. The authors stress that the rainfall pattern tends to show a number of consecutive years with rainfall amounts below, as well as above, long-term averages. Consequently, it is appropriate to talk about extreme periods, with a duration of several years, and not only extreme events. This kind of variability is a dire reality that humanity has faced for millennia, whether it is farmers trying to maintain productivity during drought periods, or planners trying to cope with floods and to supply water during periods and to areas where there is no water naturally. Risks related to climate variability are particularly large for small-scale farmers in dry climate regions. They suffer from frequent dry spells with direct repercussions on crop yields and total production in individual seasons. Multi-annual drought periods are devastating also after the period terminates since farmers have to sell off whatever assets they have just to survive. Scrapped of resources to commence cultivation when the rains return and with traumatic experiences passed from one generation to the next, their capacity and attitude to break out of a vicious circle are hampered.

The article addresses core challenges related to coping with climatic uncertainty, in particular droughts as seen from different aspects: rainwater/meteorological, green water/soil moisture/agricultural, and blue water/hydrological. Coping differences are discussed in relation to differences in time and landscape scales with a differentiation between intra-seasonal dry spells, inter-annual droughts of different length and a gradual aridification of climate. With the attention paid to water security in virtually all societies for social and economic development and the associated belief in physical structures to manage water, cultural resistance to natural variability is discussed. It is argued that some water phenomena may be seen as ‘negotiable’, whereas others are ‘non-negotiable’, i.e. the water deficits caused by long-term meteorological droughts. With climate change, physical water scarcity will hit the very foundation for livelihoods and be especially hazardous in communities where alternative livelihoods are missing.

The authors conclude that variability and unpredictability of rainfall is a neglected but most hazardous dimension of climate and water resources and a tangible development predicament. Describing and analysing the world and its water resources in terms of statistical averages and trends is natural and necessary, for example, as an input in planning and policy. But the very complex and dynamic reality must be duly recognized. Policies must include a range of approaches and the political will must be combined with political skill to balance attention to ‘privileged problems’ and to problems that have been ‘neglected’. This entails a widening of the perception of water resources to include the

various fractions of rainfall. An improved efficiency of the rains would translate into the notion of 'more crop per rain drop'. A coordinated and flexible management of the physical and biological resources of a landscape and a capitalizing of the abilities of people, communities, and governing bodies and agencies is required to deal with the complexity.

Climate Change Adds a New Dimension to Variability

Together, these five articles clarify that rainfall variability is a reality that humanity has faced for generations and throughout human and social history, whether it is farmers trying to maintain productivity during drought periods or planners coping with excesses during floods. In real life there is rarely an average year. Climate change adds a new dimension to variability with more frequent and extreme events and, indeed, periods. The combination of a more unpredictable and erratic rainfall pattern and increasing temperatures, increasing evaporation, implies a new dimension in water scarcity; farmers and societies will have to cope with and adapt to tightening physical preconditions, while at the same time adapting to globalization. It is important to realize that even though climate change with a more pronounced variability and unpredictability in rainfall is a tremendous threat to livelihoods and a stable and acceptable socioeconomic development, there are other large-scale changes that have to be considered, notably dynamic demographic and socioeconomic needs and wants, which will augment pressure and stiffen the competition for water and land resources.

These trends will provide challenges and risks in large parts of the world with a burgeoning population, but also opportunities for the farmers and societies in other parts of the world. Renewed support to farmers and societies in the first category is vital in terms of programmes and projects by, for example, government agencies, research bodies and lending institutions. The division between those who have and those who have not is serious for all. Risks related to climate variability are particularly large for small-scale farmer families and communities in dry climate regions: risk for floods, inundations, frequent dry spells and prolonged drought periods with repercussions on crop yields, total production and the capacity to make use of resources when and where they appear. Experience shows that a substantial yield gap exists in large parts of this region, which it will be even more important to reduce. Strategies that may increase the efficiency of the rains will be vitally important, i.e. not only the water-use efficiency in the agricultural systems dependent on blue water resources.

Apart from *in situ* and regional approaches with improved water and land resources management, trade and other exchanges are required. Arrangements that will facilitate contacts between farmers and the growing demand for food and other agricultural commodities in rapidly growing urban centres will be equally important, e.g. marketing arrangements that could reduce price fluctuations typically faced by farmers who have to rely on local markets.

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