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A World without Water: Sustainable Agriculture and the Role of Wetlands Conservation in Global Food Security

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Abstract
Wetlands typically offer a wide variety of benefits to society. They have played a central role in human development throughout history. These habitats contribute in diverse ways to the livelihoods of millions of people. They are often inextricably linked to agricultural production systems. In many places, growing population, in conjunction with efforts to increase food security, is escalating pressure to expand agriculture within wetlands. The environmental Impact of wetland agriculture can have profound social and economic repercussions for people dependent on ecosystem services other than those provided directly by agriculture. If wetlands are not used sustainably, the functions which support agriculture, as well as other food security and ecosystem services are undermined. Currently, the basis for making decisions on the extent to which, and how, wetlands can be sustainably used for agriculture is weak. There is a dearth of knowledge on the best agricultural practices to be applied within wetlands and a lack of understanding on how to establish appropriate management arrangements that will adequately safeguard important ecosystem services. Efforts have been made in this study to examine the role of agricultural use of wetlands in global food security. On the other hand, we also attempted to show that over-exploitation of such habitats can have destructive effects on human well-being. Hence we suggest that utilization of wetland should be performed through wise use of these habitats and sustainable agriculture in order to preserve them for future generations. Finally, we conclude that all international actors and above all contracting parties to the Ramsar Convention should fulfill their obligations under this convention to stop loss and degradation of wetland ecosystems.

Keywords: Wetland Conservation, Food Security, Wise Use of Wetlands, Sustainable Agriculture, Ramsar Convention.

Introduction

Water is a surprisingly limited commodity. Over the next 30 years, the global water supply is in danger of drying up. The link between water and food is a simple one. Crops and livestock need water to grow. Agriculture accounts for 70% of all water withdrawn by the agricultural, municipal and industrial (including energy) sectors. Water is the key to food security.

The world population is projected to reach nine billion by 2050 (UN, 2007). Not only will these people need water to drink and bathe with also a massive amount of water must be used to grow additional food. Global population growth results in higher demand for more and better food (Millennium Project, 2005). To meet this demand, agriculture will have to expand irrigation water use. Yet, competition for water resources is expected to intensify and climate change will further stress water availability. Within these constraints, the optimal solution is to improve the productivity of water in agriculture - higher agricultural production with the same amount of water or the same production with less water. Water savings could then be reallocated to other, high-value uses.

Water is indisputably one of the most precious of all natural resources especially wetlands and the limiting factor in economic and social development (Chenoweth J, 2008). Freshwater resources globally are being over-exploited, polluted, and degraded and many systems are on the brink of collapse. Wetlands are species-rich habitats performing valuable ecosystem services such as flood protection, water quality enhancement, and food chain support and carbon sequestration.

Agriculture and wetlands have not had a very harmonious relationship. In the course of history, wetlands have been reclaimed for agriculture in many parts of the world with ever more effective drainage and land amelioration measures. The natural wetland ecosystems reclaimed in this way have lost much of their original character, leading to reduced biodiversity and reduced performance of functions other than crop productivity ([1]. Hassan R, Scholes R, Ash N, 2005). The need to expand agriculture to feed a growing population has in many places led to a major conversion of wetlands into farmland. Worldwide this led to the well-known, often quoted, though hard to document estimate of 50% of the world's wetlands that were lost to agriculture and urbanization in the twentieth century (Verhoeven J, T, A, and Tim L. Setter, 2009).

The interest in the sustainability of agricultural and food systems can be traced to environmental concerns that began to appear in the 1950s and 1960s. Today, concerns about sustainability center on the need to incorporate agricultural technologies and practices that (i) do not have adverse effects on the environment (partly because the environment is an important asset for farming); and (ii) are accessible to and effective for farmers, and lead both to improvements in food productivity and have positive side-effects on environmental goods and services. Sustainability in agricultural systems incorporates concepts of both resilience (the capacity of systems to buffer shocks and stresses) and persistence (the capacity of systems to continue over long periods), and addresses many wider ecological, economic and social and political dimension.

In this regard, efforts have been made in this survey to examine the role of wetlands protection and wise use of these habitats in global food security through sustainable agriculture. The method that have been used in this study is descriptive-analytical.

Concepts and Definitions

Wetland definitions often include three main components. Wetlands are distinguished by the presence of water, either at the surface or within the root zone, seasonally or permanent, they often have unique soil conditions that differ from adjacent uplands, and they support vegetation adapted to the wet conditions (hydrophytes) and, conversely, are characterized by an absence of flooding-intolerant vegetation (Mitsch WJ, Gosselink JG. 2007).

Wetland ecosystems have been recognized to provide various services (De Groot RS, Wilson MA, Boumans RMJ, 2002, Zaidi PH, Rafique S, Rai PK, Singh NN, Srinivasan G, 2004, Verhoeven JTA, Beltman B, Whigham DF, Bobbink R, 2006). Services often performed/provided by wetlands include storm water detention, flood protection, water quality enhancement, freshwater fisheries, food chain support, feeding grounds for juvenile marine fish, biodiversity, carbon storage and climate regulation (Hassan R et al, op cit).

Wetlands are also used to secure food not only directly through dry season subsistence cultivation but also indirectly through income generation from cash crops, the production of clay for pottery, reed and palm mats, baskets and beehives, and the sale of collected items, thus acting as safety nets for most adjacent communities (Maclean I, Tinch R, Hassall M, Boar R, 2003). In the drier regions, wetlands are the only sites where people can get water, varieties of food and other basic supplies (Shackleton CM, Shackleton S, 2006, Mwakubo SM, Obare GA, 2009). Therefore, Wetlands play an essential role in supporting food security.

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (Food and Agriculture Organization of the United Nations, 2011). Food security covers availability, access, utilization and stability issues, and in its focus on individuals also embraces their energy, protein and nutrient needs for life, activity, pregnancy, growth and long-term capabilities. Sustainable agriculture is not officially defined but generally refers to the capacity of agriculture over time to contribute to overall welfare by providing sufficient food and other goods and services in ways that are economically efficient and profitable, socially responsible, and environmentally sound (UNCSD Secretariat, 2011).

Reclamation of wetlands for agriculture has mostly involved drainage and soil improvement, and these measures have often totally destroyed their ecological character and the ecosystem services that go with it. Agriculture and wetlands should be managed in unison in order to conserve vital ecosystems and support the livelihoods of millions of people. Boasting a wealth of wildlife, providing water and food for people and livestock, and playing a crucial role in the hydrological cycle, the debate around conservation of wetlands has been polarized for years, with agriculture implicated as one of the greatest threats to their survival. But now there is a growing consensus that a 'people-centered' approach that seeks to optimize the benefits for smallholder farmers and reduce poverty, while simultaneously protecting biodiversity and ecosystems, is the most promising approach for long-term conservation of wetlands (International Water Management Institute, 2014). One of these great approaches is sustainable agriculture that can somehow prevent from unwise use of wetlands habitats.

What, then, do we now understand by sustainable agriculture? Many different expressions have come to be used to imply greater sustainability in some agricultural systems over prevailing ones (both pre-industrial and industrialized). These include the terms biodynamic, community-based, Eco agriculture, ecological, environmentally-sensitive, extensive, farm-fresh, free-range, low-input, organic, permaculture, sustainable and wise-use (Giddens, A. 1987, Checkland, P. and Scholes, J. 1990). Systems high in sustainability can be taken to be those that aim to make the best use of environmental goods and services whilst not damaging these assets (Gliessman S R. 2004). The key principles for sustainability are to: (i) integrate biological and ecological processes such as nutrient cycling, nitrogen fixation, soil regeneration, allelopathy, competition, predation and parasitism into food production processes; (ii) Minimize the use of those non-renewable inputs that cause harm to the environment or to the health of farmers and consumers; (iii) Make productive use of the knowledge and problem-solving skills of farmers, so improving their self-reliance and substituting human capital for costly external inputs; (iv) Make productive use of people's collective capacities to work together to solve common agricultural and natural resource problems, such as for pest, watershed, irrigation, forest and credit management.

The idea of agricultural sustainability, though, does not mean ruling out any technologies or practices on ideological grounds. If a technology works to improve productivity for farmers, and does not cause undue harm to the environment, then it is likely to have some sustainability benefits. Agricultural systems emphasizing these principles also tend to be multi-functional within landscapes and economies (Dobbs T and Pretty J N. 2004, MEA (Millennium Ecosystem Assessment). 2005).

Agricultural Use of Wetlands and its Impact on These Habitats

The needs of agriculture for flat, fertile land with a ready supply of water mean that wetlands are often a potentially valuable agricultural resource. In arid and semiarid regions with seasonal rainfall patterns the capacity of wetlands to retain moisture for long periods, sometimes throughout the

year and even during droughts, means that they are of particular importance for small-scale agriculture, both cultivation and grazing.

Wetlands have been used for agriculture for millennia, especially riverine wetlands in floodplains where soils are fertile and water is plentiful. Indeed, wetlands have nurtured the development of many important cultures around the world – but the downside is that drainage and reclamation of wetlands for agriculture has become ever more widespread and effective. In some regions of the world more than 50% of peat lands, marshes, riparian zones, lake littoral zones and floodplains have been lost, with conversion for agricultural uses being one of the primary reasons for these ongoing wetland losses. Today, roughly 2.5 billion rural people depend directly on agriculture for their livelihoods. Thus agriculture is often a primary driver of economic growth in developing countries and provides critical economic support for poor rural households.

Wetlands provide food and other agricultural products such as fuel and fiber directly through agricultural production activities that take place within wetlands, such as in rice paddies, coastal grazing marshes, recession agriculture and aquaculture in large floodplains, and cropping of small seasonal wetlands. Wetlands also support agriculture indirectly, for example by providing fertile soils and reliable supplies of good quality water.

Given their importance for water supply and food production, wetlands are a key element of achieving the goals of poverty alleviation worldwide. They can literally be lifesavers – for example, oases and springs, particularly in arid regions, that support dry season food production, water and grazing for livestock.

Wetlands are also increasingly being impacted by activities related to energy production, for example through demands for water and large-scale conversion of wetland areas for the cultivation of biofuels.

In recent decades, agricultural use of wetlands has increased significantly in many developing countries, particularly in Africa, where they are perceived by some as the "new frontier" for agriculture (Wood, A. 2009). This increase is driven partly by population growth, partly by the degradation of overexploited upland fields, and partly by market opportunities and the need to earn cash income (Wood, A.; van Halsema, G.E. 2008).

Although wetland agriculture can bring significant benefits in terms of food security, health and income, ill-considered development often results in wetland degradation, deleterious environmental impacts and harmful consequences to peoples' livelihoods. Impacts on wetlands can be derived from human activities that occur within wetlands and, because of the interconnectedness of the hydrological cycle, also from activities that take place within the wider catchment. Through removal of water or by alteration of natural flow, chemical, and sediment regimes, human exploitation of both surface water and groundwater resources can have major detrimental consequences for wetland ecosystems.

Clearing and draining wetlands for agricultural expansion and the modification of hydrological and other fluxes have been the primary cause of wetland degradation in the past. Damming of rivers, withdrawal of river water and groundwater abstraction have all resulted in the desiccation of many wetlands. Pollution from the use of fertilizers and pesticides has adversely impacted natural biota (including fish) and undermined the ecological character of many wetlands. It is estimated that more than 50% of some wetland types in North America, Europe, Australia and New Zealand have been lost, largely as a consequence of human activities directly related to agriculture (MEA, 2005). In contrast, it has been estimated that by 1985, 27% of wetlands in Asia (i.e., about 80 Mha) and 2% of wetlands in Africa (i.e., about 3 Mha) had been drained for intensive agriculture (Ibid).

There are many ways in which poorly managed agriculture can negatively impact wetlands. This can lead to changes in the ecological character of a wetland and the possible permanent loss of its benefits to people.

- Water quantity impacts: Decreases inflows due to the building of dams and abstraction of surface water and groundwater for irrigation or other purposes, increases in river flows or water levels due to irrigation return flows or dam releases, and changes in the timing and patterns of river flows can all significantly alter and sometimes damage the ecological character of wetlands. Many coastal wetlands depend on the nutrients and sediments carried down by rivers to maintain their ecological character.

- Water quality impacts: Intensive agriculture activities including intensive aquaculture often lead to increased loads of pollutants such as pesticides, fertilizers, antibiotics and disinfectants. Not only do these affect the ecological character of both inland and coastal wetlands, they also have impacts on human health and the quality of drinking water supplied from wetlands.
- Wetland conversion and disturbance: Agricultural activities which can disturb wetland functions and ecosystem services include the drainage and conversion of wetlands to cultivated land or aquaculture; the introduction of invasive plant and animal species; the introduction of human and animal disease vectors; and the disturbance of breeding, migration and feeding patterns of wetland fauna. For example, the rapid expansion of intensive shrimp farming has contributed to the loss of large areas of coastal wetlands in several countries, with an associated loss of wetland ecosystem services such as coastal storm protection, fisheries, and mangrove forest products

The Role of Wetlands Conservation in Food Security

Food is the basic human need for survival, health and productivity. It is the foundation for human and economic development Lisa LC, Alderman H, Aduayom D, 2006).

Food security, meaning access to adequate food for all, at all times, requires inter-alia sustainable and increased production and productivity in the agricultural sectors well as more equitable distribution of food produced. Hence food security is the product of many variables including physical factors such as climate, soil type and water availability; management of these and other natural resources (water, land, aquatic resources, trees and livestock), at the level of fields, landscapes and river basins; and losses and waste along the value chain. It also requires adequate policies and institutions in the many sectors that influence the ability of men and women to produce and purchase food, and the ability of their families to derive adequate nutrition from it. On the other hand, food insecurity occurs when food systems are stressed such that food is not available, accessible or utilized properly.

With a growing global population expected to reach 9.1 billion in 2050, sustainable use of water and ecosystems for food security is a great challenge. It is important to gain a better understanding of the functioning of terrestrial and aquatic ecosystems and their interrelation with the availability and quality of water. This calls for a shift in the management of ecosystems and the water within them for food security. Agricultural production systems have to be recognized and managed as a landscape of interlinked agro ecosystems with the potential for multiple functions.

Many drivers of global change affect water availability and thus agro ecosystems and food security, by limiting or taking away the water necessary for maintaining ecosystem functions. This is a challenging development since ecosystem functions and food security go hand in hand: healthy ecosystems enhance food security while degraded ecosystems decrease food security. Healthy ecosystems are particularly important for the poor who predominantly directly rely on ecosystem services. Water is the important link between agro ecosystems and food security and it is important that the right balance of water is provided to each of these needs in order to sustain both functions.

Globally, about one billion people, mostly from developing countries are under-nourished. Most of these people live in countries that are not self-sufficient in food production, in particular in south Asia and sub-Saharan Africa. The livelihoods and well-being of these people is critically dependent on their farm produce, and on the local landscape with its ecosystem functions, to provide ecosystem services that sufficiently support their livelihoods and income. Water is a key driver of several ecosystem functions, including biomass and crop yields, as well as various supporting and regulatory ecosystem services. It is also a principal input in enhancing food production, irrigation being a well-established method of improving yield in many parts of the world (CA (Comprehensive Assessment). 2007).

The understanding of linkages between ecosystems, water, and food production is important to the health of all three, and managing for the sustainability of these connections is becoming increasingly necessary. In many places, changes in the global water cycle, caused largely by human pressures, are seriously affecting ecosystem health and human well-being (MEA, 2005).Widespread land degradation driven by bad agricultural practices is seriously limiting food production (Bossio, d.; Geheb K. eds. 2008).

Wetlands play a critical role in the survival of many communities across the world, particularly in semi-arid areas where, during dry periods, they are an important source of water for domestic use and the production of crops. In most parts of the world, rural communities suffer from seasonal variations in food supply and the "hungry season" is a key feature of life for many millions of people. This food shortage is often addressed by the drainage of wetlands or the use of areas with seepage water or a high water table to produce food crops in the dry season. Such crops can make a dramatic impact upon the availability of food in the hungry season, and even though the production is small, its value is great. In some areas where uplands are badly degraded, wetlands can play a very important role in food security (Wood Adrian, Alan Dixon, 2003).

With agricultural expansion into wetlands and the growing need for more food, it is important that the functions of these agro ecosystems are seriously considered and managed in terms of their contribution to environmental services (Wood, a.; van Halsema, G.E. 2008). Wetland agro ecosystems are common in less developed countries across the world; however, they have often been managed in isolation – disconnected from the river basin system.

On the other hand, wetlands are further threatened by climate variability. The findings of the IPCC third and fourth assessment reports confirm that the changing water cycle is central to most of the climate change-related shifts in ecosystems and human well-being (Pachauri, R.K.; Reisinger, a. 2007). By 2050 climate change is also anticipated to have significant impacts on coastal wetlands through both changing hydrology and sea level rise. The future use of water and land for agriculture will further constrain the ability of the wetland system to respond to climate change. Coupled with ever-increasing human pressures, such as high-density populations and associated needs, wetlands and their ecosystem services are seriously threatened unless the issues are urgently addressed and managed effectively. Hence, when water resource issues are to be addressed in climate change analyses and climate policy formulations, changes in the water cycle have to be considered as important starting points for interventions. Climate change variability will increase the need for improved water storage and the role of wetlands and other water-based ecosystems in this should be recognized (Mc Cartney, m.; Smakhtin, V. 2010).

In view of the importance of wetlands in delivering ecosystem services, including the achievement of water and food security, the implication of most climate change scenarios is that it is more urgent than ever to achieve better management of wetland ecosystems in order to sustain water supplies and the other ecosystem services they provide.

Sustainable Agriculture: an Approach toward Wetlands Conservation

The 21st century has seen a growing concern about the negative changes produced by agriculture on various ecosystems across the world: destruction of soil cover, topsoil depletion, reduction of biodiversity, groundwater contamination and the increasing costs of production, as well as the progressive disintegration of family farming and indigenous systems. The Millennium Ecosystem Assessment showed that agriculture has dramatically increased its ecological footprint, both in terms of negative impacts but also in terms of its supply of ecosystem services for rural communities (MEA, 2005). Particularly, the high demand for water and land in commercial farming systems and with it the increased risks of pollution has led to the need for a more economically, socially and environmentally viable agricultural systems in order to avoid ecosystem destruction.

Wetlands and agriculture are closely interlinked. Agriculture depends on wetlands for water – 70% of all water withdrawals from aquifers, streams and lakes is used for agriculture. Wetlands in turn depend on sustainable agricultural practices that manage water use so that wetlands remain healthy and can continue to provide their many benefits to people and nature.

Wetland – agriculture interactions, if poorly managed, come with a cost to society and to wildlife. Wetlands are increasingly threatened by agriculture's growing demands for water and land. Wetland drainage and conversion to cultivated land or aquaculture are highly visible examples of the negative impacts of agriculture on wetlands. Less visible but equally harmful are the widespread use of noxious pesticides and excessive use of fertilizers that may contribute significantly to wetland pollution.

How to find the right balance? It all comes down to ensuring that wetlands are used wisely, to finding sustainable management solutions for the benefit of agriculture and wetlands.

The idea of sustainable agriculture is popular among people interested in alternative systems of agriculture which minimize the potential negative effects of feeding growing populations. But agricultural sustainability means different things to different people.

Sustainable agriculture is the act of farming based on an understanding of ecosystem services, the study of relationships between organisms and their environment. It has been defined as "an integrated system of plant and animal production practices having a site-specific application that will last over the long term". Sustainable agriculture can be understood as an ecosystem approach to agriculture (Altieri, Miguel A, 1995).

Sustainable agriculture is a process which meets the following criteria:

- Ensures that the basic nutritional requirements of present and future generations, qualitatively and quantitatively, are met while providing a number of other agricultural products and ecosystems services.
- Provides durable employment, sufficient income, and decent living and working conditions for all those engaged in agricultural production.
- Maintains and, where possible, enhances the productive capacity of the natural resource base as a whole, and the regenerative capacity of renewable resources, without disrupting the functioning of basic ecological cycles and natural balances, destroying the socio-cultural attributes of rural communities, or causing contamination of the environment.
- Reduces the vulnerability of the agricultural sector to adverse natural and socio-economic factors and other risks, and strengthens self-reliance (FAO. 1995).

Various agricultural practices can be advocated which promote the wise use of wetland ecosystems while ensuring sustainable development. Adoption of strategies (i.e. relevant provisions of the conventions on Biological diversity and Wetlands) that work towards the environmental management of these ecosystems would link the environmental stewardship directly to poverty alleviation, food security and quality water in the wetlands (MEA, 2005). If better management is sought, the development, assessment and diffusion of applicable technologies which increase the production of food per unit of water, without harmful trade-offs, is both feasible and essential. Though such technologies have already been identified and are available, most countries (it is mostly less developed countries that are grappling with these issues) lack the financial resources to improve their capacity to adopt this approach (Ibid). However certain strategies can be adopted in order to realign policies on agriculture and wetlands (Wood and van Halsema 2008; Mc Cartney et al. 2010, op cit).

- Improve the agricultural practices of female and male farmers in ways that positively influence wetlands, while at the same time not compromising livelihoods: this can be done by increasing agricultural productivity (intensification) without expanding land area or water use, thereby not compromising the water regulative functions of wetlands; shifting from irrigation to rainfed agriculture; and improving soil management.
- Adopt supporting strategies which maintain and improve wetland ecosystem services so that a broader range of stakeholders, including the rural poor men and women, receive the benefits.
- Assess water use by the surrounding agro ecosystems and adapt its use to be in harmony with a sustainable supply using trade-off analyses.
- Improve land and water management techniques after a comprehensive evaluation of the social and ecological products and services supported by the wetlands for women and men.
- Provide alternate livestock drinking sites away from sensitive wetland areas not only for the benefit of the wetlands but also as a means to reduce animal health risks (Peden, d, et al, 2005).
- Improve awareness among all stakeholders who are involved in agricultural water management and improve their understanding of ecosystem services.
- Improve the inventories, assessment and monitoring of interactions with agro-ecosystem change and of changes to the surrounding wetland. Apply environmental monitoring and decision support systems which involve the affected local communities.

- For each water use activity, identify who are the winners and losers among men and women and affected social groups; and determine the costs and benefits incurred by each and look for ways to transfers costs into incentives to farm more sustainably.
- Adopt an integrated approach to water management that considers the whole catchment, its land use and the water and wetland ecosystems within it in a way that balance the multiple water requirements for livelihoods along with the needs of the different ecological processes of wetland ecosystem services.

The wise use of wetlands and their ecosystem services is central to the purpose of the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention). It was concluded in Ramsar, Iran in February 1971. This Convention provides a useful framework for cooperative efforts to protect wetlands and the benefits that people derive from these areas. More than 169 countries are parties to this treaty (www.tamsar.org). Although the Ramsar Convention opens with the sweeping language of its noble purposes, he duties imposed on Ramsar Parties are general and permit a large degree of flexibility in their implementation. The "three pillars," or overarching obligations, are: (1) to designate sites as wetlands of international importance; (2) to apply a "wise use" concept to all wetlands within a Party's territory; and (3) to engage in international cooperation (Ramsar Convention Secretariat, 2013).

The Convention defines wise use of wetlands as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development". Wise use can thus be seen as the conservation and sustainable use of wetlands and all the services they provide, for the benefit of people and nature. So what is wise use in the agricultural context? It means managing agriculture-wetland interactions in ways that maintain essential wetland ecosystem services; it means seeking an appropriate balance between provisioning, supporting, regulating and cultural services. The need to find this balance as well as recognize the importance of wetlands to agriculture are highlighted in Ramsar's Resolution VIII.34 (2002) on agriculture, wetlands and water resources management.

In this resolution, Ramsar Convention recognizes that agriculture is also a major form of land use and that river valleys, floodplains, and coastal lowlands in particular have frequently been used for agriculture because of their natural suitability and the demands of agriculture for flat, fertile land and a ready supply of fresh water, and that therefore there is a high priority to ensuring that agricultural practices are compatible with wetland conservation objectives. It also notes that the high dependence of local communities on wetland resources, particularly in developing countries and notably in terms of small-scale subsistence agriculture, domestic water supply, and other uses that may contribute directly to poverty alleviation and also that the poor, in particular women, often depend on wetland resources for their livelihoods and can be severely disadvantaged if wetlands are degraded or lost.

Furthermore, it noticed that agriculture can have impacts on water quantity and quality, and in particular that agriculture is a) a major user of water, and b) in certain cases, a major polluter, for example through pollution of surface and groundwater due to the runoff of fertilizers and plant protection products such as herbicides, fungicides and pesticides.

Hence, Ramsar Convention expressed that in conformity with the Ramsar 'wise use' concept concerted efforts are required to achieve a mutually beneficial balance between agriculture and the conservation and sustainable use of wetlands, and to prevent or minimize the adverse effects from agricultural practices on the health of wetland ecosystems throughout the world, taking into account the precautionary approach as set out in Principle 15 of the Rio Declaration on Environment and Development.

It is important that use of any wetland for human development actions such as agriculture or others should take into account the ecological dependence of various species on these ecosystems and as far as possible employ a level of precautionary approach in assigning uses to wetlands. Likewise, it is imperative that the net gain to society and sustainability of proposed uses of wetlands be clearly outlined.

The Ramsar Convention does not advocate a "no-use, strict protection" approach, but instead calls for a more informed and cautious approach to assigning uses to wetlands and for greater attention to integrated planning in the watershed areas. This may be achieved through involvement of wetland conservation experts in discussions and implementation of proposed projects and by strengthening studies and research in wetlands in order to gain better understanding of their potentials and limitations. Implementation of this approach requires a holistic approach to planning which involves all stakeholders in and around wetland areas, and preferably within the watershed.

Global solutions are few, since climate, wetlands, agriculture and communities vary so greatly from region to region. Yet experience and observations from many wetlands show that it is indeed possible to find mutual benefits for agriculture and wetlands, particularly when local solutions are implemented using local knowledge, within larger integrated planning efforts.

The most effective solutions to the question of balance tend to be those that employ a combination of approaches, including: agricultural practices that help to reduce impacts on wetlands; development of multifunctional agro ecosystems which are managed to provide the broadest possible range of wetland ecosystem services; and restoration of wetlands to provide functions and services in agricultural landscapes.

Here are some ways that can help reducing the impacts of agriculture on wetlands: a) More “crop per drop”: There is still much scope for improvement in water productivity and management in both irrigated and rain-fed agriculture[1]. Highly efficient irrigation technologies are becoming more widely available; drought-tolerant crop varieties are reducing irrigation needs; and cultivation of more flood-tolerant crops could reduce the need to drain wetlands. Traditional agricultural water management practices can be made more effective with smartphone technologies that allow farmers to access weather and crop data in the field. Water re-use and wastewater use in agriculture can reduce withdrawals from wetlands. Return flows from urban areas could provide valuable water resources for agriculture, and wetlands can help to provide treatment before this water is used for agriculture, b) Integrated water resources planning: While large dams will remain an option for reducing the vulnerability of farmers to drought and for increasing production, small local storage options such as tanks and farm dams provide local resilience: for example, the ancient irrigation systems of Sri Lanka utilize networks of large and small reservoirs called “tanks”, which are frequently a rich source of wetland biodiversity. Larger dams can be designed and operated for multiple uses such as agriculture, hydropower, fisheries, and recreation, and should allow water releases for downstream ecosystems, c) Reducing the impacts of agriculture on water quality: Options such as conservation tillage and organic farming practices can reduce the pollution loads reaching wetlands. Integrated pest management and targeted life stage interventions can help to reduce the need for pesticide. Combined production systems can utilize livestock manure to fertilize crops and aquaculture. In small, intensive operations and family farms these strategies can reduce input costs significantly.

Alongside with these approaches, there are also two ways for reducing the impacts of agriculture on wetlands. One of them is managing land and water for Multifunctional agro ecosystems. Conventional commercial agriculture has tended to focus on a single provisioning ecosystem service or at most a narrow range of services such as one or other of grain, fiber, fish, and meat or biofuel production. In a multifunctional agro ecosystem approach, farmers manage land and water for a larger set of ecosystem services. Where wetland ecosystem services are involved, this requires a good hydrological and ecological understanding of the landscape so that production systems deliver not only provisioning services but also essential regulating, supporting and cultural services. An approach that recognizes the values of the full range of ecosystem services will also allow farmers to identify where and how net benefits could be achieved.

1. The term Rain-fed agriculture is used to describe farming practices that rely on rainfall for water. It provides much of the food consumed by poor communities in developing countries.

The other approach is to restore wetlands in agricultural landscapes. Restoring wetland functions and securing water allocations to maintain the ecological character of wetlands can be viewed as investments in the natural infrastructure that wetlands provide for agriculture. Wetlands on agricultural land can help to manage flood waters in the wet seasons, improve soil moisture conditions, provide more local water storage for irrigation in the dry season, and provide water for ecosystems downstream.

Conclusion

Throughout history, wetlands have played an important role in human development and many Great civilizations depended on them. Agriculture is a commonly associated feature of wetlands throughout the world, with millions of hectares of wetland of various types supporting a wide range of activities. Conversely, many wetlands are threatened by these same agricultural practices, which modify the hydrological and other natural regimes on which they depend, and hence, their ecological character and the other benefits they provide.

As the human population increases and further influences the management of water and other natural resources, the value of wetlands to society increases, but so also do the pressures on them.

Wetland agriculture is important for poverty reduction and food security in many developing countries. However, there is little recognition of its current extent, its value to poor communities or its future potential. A major constraint is lack of knowledge by government planners, managers of natural resources and local communities of the diverse benefits they provide and how they can be utilized for agriculture in a sustainable manner.

Frequently, the threats of drainage and overexploitation of resources are perceived as key issues in determining wetland utilization for agriculture, but with limited and, often, misconceived, understanding of actual impacts and trade-offs with other ecosystem services.

There is little consensus about what constitutes “wise use” of wetlands and there is often tension between conservation and development approaches that is rarely reconciled. Frequently, wetland policies are driven by a conservation agenda that actively discourages or ignores wetland agriculture.

Water is already scarce and improving food security will put more pressure on water resources and ecosystems. With increasing trans-boundary as well as urban-rural tensions, finding an equitable way to distribute water seems difficult. It is possible to produce the food needed, but if present practices continue it is not probable that this will solve the many poverty and environmental challenges confronting us. When water for ecosystems and water for food are considered separately, additional tension is created and the problem gets even more challenging. Hence, in order to share a scarce resource and guarantee long-term sustainability, it is imperative to find wiser ways to meet future water demands. For sustainable water use, water managers must consider agriculture as an ecosystem with all its services, and in turn consider how these services may be impacted by water. Agro ecosystems are huge providers of food, animals, products, services and incomes which could ensure food security, if they are well managed, in sustainable ways, to maintain ecosystem functions and benefit from the full range of ecosystem services. This calls for a shift in the management of water from water for food to water for multifunctional agro ecosystems, considering the whole ecosystem base of provisioning, regulatory, cultural and supporting services.

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