Wetlands, Livelihoods and Human Health

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Abstract In developing countries millions of people live a life of subsistence agriculture, mired in poverty, with limited access to basic human needs, such as food and water. Under such circumstances wetlands, through the provision of a range of direct and indirect ecosystem services, play a vital role in supporting and sustaining peoples' livelihoods and hence, their health. This chapter discusses the role of wetlands in the context of the sustainable livelihoods framework in which wetlands are viewed as an asset for the rural poor in the form of "natural capital". The framework is used to illustrate how ecosystem services, livelihoods and health are entwined and how the ecosystem services provided by wetlands can be converted to human health either directly or via other livelihood assets. It highlights the contributions that wetlands make to basic human needs and, either directly or through transformations to other forms of livelihood capital, the support they provide to livelihoods and overall well-being.

Keywords Livelihood · Ecosystem service · Well-being · Natural capital · Physical capital · Financial capital · Social capital · Development · Poverty · Floodplain · Agriculture

Introduction

As aptly illustrated by others, the inter-relationships between wetlands and human health—a key contributor to human well-being—are complex and dynamic (Horwitz and Finlayson 2011; Horwitz et al. 2012; Finlayson and Horwitz 2015). Since livelihoods are a vital determinant of well-being many wetland-health links are

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mediated through peoples' livelihoods. Good health is essential for people to maximise livelihood opportunities. Peoples' livelihoods are undermined by poor health and conversely health is impaired by poor livelihoods.

The links between wetlands, livelihoods and health have long been recognized. In the past, in many places, wetlands were viewed as unproductive (i.e. supporting few livelihoods) and the source of disease. For example, in Europe wetlands were widely perceived as wastelands, a source of malaria, and best drained and converted to agriculture. Consequently, during the seventeenth and eighteenth centuries major drainage schemes converted thousands of square kilometres of wetlands, much of which is now highly productive farmland (Cook and Williamson 1999). As a result, throughout much of Europe there is now a range of highly modified and degraded wetland landscapes (Acreman and José 2000). For example, in the Fenlands of eastern England, human activities have transformed all but 0.1% of the original wetlands (Mountford et al. 2002).

Over the last 30 or 40 years, as European societies have become wealthier and food security less of an issue, societal values have changed. Wetlands are now widely perceived to be highly productive ecosystems that maintain environmental quality, support biodiversity, and contribute to livelihoods directly and indirectly (MA 2005). As a result, in Europe there is now a significant effort not only to conserve what little wetland habitat remains but to enlarge it through restoration activities (Colston 2003).

In contrast to Europe, across much of Africa and Asia, high proportions of the population remain extremely poor and food security is a key priority for many. However, there has been much less transformation of wetlands. Largely unmodified wetlands remain key elements of the landscape and are a vital resource, supporting the livelihoods of many millions of people (Wood et al 2013). For these people, their health is inextricably connected—in a myriad of direct and indirect ways—to the wetlands in which they live and work. Many wetland contributions to livelihoods result in positive health outcomes. However, there are also features of wetland ecosystems that can adversely affect livelihoods and/or result in negative health outcomes. Thus the reality is that in relation to livelihoods and health, wetlands present both good and bad prospects. They are effectively a "double edged sword" and the extent to which the good outweighs the bad depends a lot on site specific factors including exactly how people interact with wetlands and, importantly, how the wetlands are managed (Horwitz and Finlayson 2011; Horwitz et al. 2012).

The contributions that wetlands make to peoples' livelihoods arise from the interaction of the ecological functions they perform with human society (Fig. 1). Wetlands are seen to provide a wide range of "ecosystem services" that benefit livelihoods and societies. Depletion of ecosystem services is widely believed to translate into fewer livelihood benefits for people and therefore lower net human well-being. However, paradoxically many people who live in Africa and Asia are "wealthy" in terms of wetland ecosystem services but are otherwise extremely poor, experiencing hard lives, very low levels of well-being and poor health (Horwitz and Finlayson 2011; Finlayson and Horwitz 2015).

Generally rural communities are poor because they are not able to effectively capture the full benefits associated with the use of natural resources, in part because

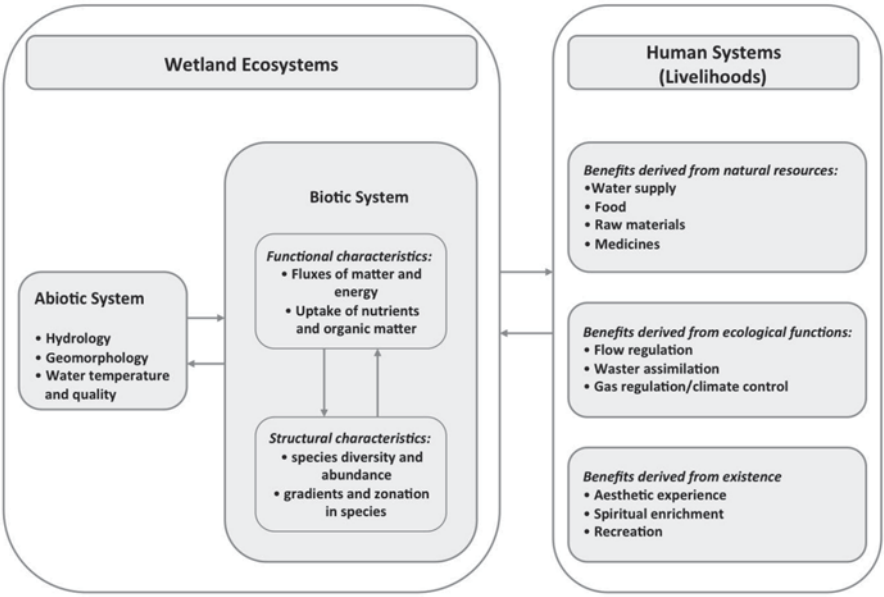

Fig. 1 A representation of the influence of wetland ecosystems on human livelihoods. (Adapted from Lorenz et al. 1997)

resources are used primarily for subsistence. To lift people out of poverty requires the identification of, and the capacity to utilize, opportunities to improve their livelihoods through economic activities: moving beyond subsistence to using the available resources in an efficient, equitable, productive and sustainable manner. Increasingly, livelihood approaches have focused on how natural resource can be used as an asset to improve peoples' well-being and promote development. This in turn inevitably requires some change to the environment. However, significantly altering wetland ecosystems for economic development can adversely affect the very ecosystem services on which the poor most depend and often results in unintended, negative consequences for the most vulnerable.

Thus there is a paradox: it is necessary to alter ecosystems to facilitate development but in altering them key ecosystem services may be undermined. The challenge for sustainable development is to obtain the right balance between socio-economic development and sustaining key ecosystem services. A prerequisite for obtaining such a balance is a comprehensive understanding of exactly how ecosystem services contribute to livelihoods and peoples' well-being and health. The dichotomy created by this paradox has been recognized by the Ramsar Convention on Wetlands. The "wise use" concept is an attempt to address it (Finlayson et al. 2011) by promoting sustainable development through the maintenance of the ecosystem services that wetlands provide. However, whilst acknowledging the importance of the wise-use concept, others argue that the "maintenance of ecological character" may reduce opportunities for the poorest and call for a more "people-centred" approach to wetland management in developing countries (Wood et al. 2013). In such

circumstances, sustainable development requires that peoples' use of wetlands are related to development pathways and trade-offs in ecosystem services.

This chapter provides an overview of the links between wetlands, livelihoods and human health, and presents a conceptual framework (based on the sustainable livelihoods framework) that illustrates how ecosystem services, livelihoods and health are entwined and how the ecosystem services provided by wetlands can be converted to human health either directly or via other livelihood assets (i.e. financial, physical and social). The links between wetlands and poverty are then explored before drawing conclusions about wetlands as settings for livelihoods and human health.

The Concepts: Ecosystem Services, Livelihoods and Health

The concepts of ecosystem services, livelihoods and health are all multi-faceted human constructs. Consequently, it is not surprising that the inter-relationships between them are intricate and multi-dimensional. Below the different concepts are described and a conceptual framework illustrating the inter-linkages between them is presented.

Ecosystem services as defined by the Millennium Ecosystem Assessment are simply "*the benefits people obtain from ecosystems"* (MA 2005). The services that wetlands provide vary depending on both the biophysical characteristics of the wetland and its catchment and the presence and differing needs of beneficiaries. Four broad classes of ecosystem services have been identified (MA 2005; Fig. 2). Typically, the physical benefits from wetlands include "provisioning services" such as domestic water supply, fisheries, livestock grazing, cultivation, grass for thatching, and wild plants for food, crafts and medicinal use. Other ecosystem services are often not explicitly recognized by communities, but include a wide range of "regulating services" such as flood attenuation, maintenance of dry-season river flows,

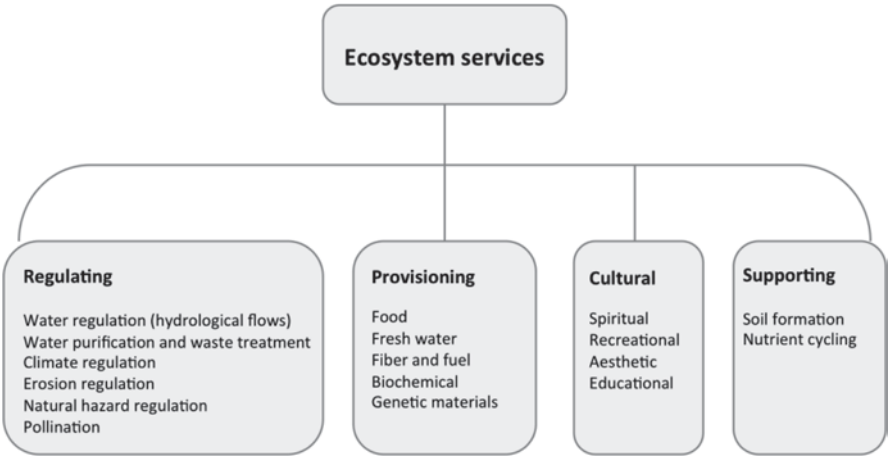

Fig. 2 Ecosystem services provided by or derived from wetlands. (McCartney et al. 2010, adapted from MA 2005)

groundwater recharge, water purification, climate regulation and erosion control, as well as a range of "supporting services" such as nutrient cycling and soil formation. In addition, people also gain nonphysical benefits from "cultural services", including spiritual enrichment, cognitive development and aesthetic experience. In many instances, different services may be closely linked. For example, where people attach spiritual value to soils and water, wetland provisioning services may be linked to cultural services. Thus, wetlands bring a wide variety of tangible and intangible benefits to large numbers of people and in this respect they provide settings for human well-being and health (Horwitz and Finlayson 2011). The way they do this is complex and multi-dimensional and is directly related to the specific features and ecological functions of the wetland.

Human Health is a key component of human well-being. Human well-being is multidimensional and defined as *the ability of people to determine and meet their needs and to have a range of choices and opportunities to fulfil their potential* (Prescott-Allen 2001). As such it requires the tackling of a diverse range of challenges—environmental, social and economic—and widening the options available to people to make a living and to participate usefully in society. The Millennium Ecosystem Assessment (MA 2005) conceptualised human well-being as representing the basic material needs for a good life, the experience of freedom, health, personal security and good social relations. Combined, these provide the conditions for physical, social, psychological and spiritual fulfilment. In this context human health is defined as "*a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity*" (WHO 2006). Many factors determine a person's health including complex interactions with the physical environment in which they live, the person's individual characteristics and behaviours, and the social and economic environment (Fig. 3).

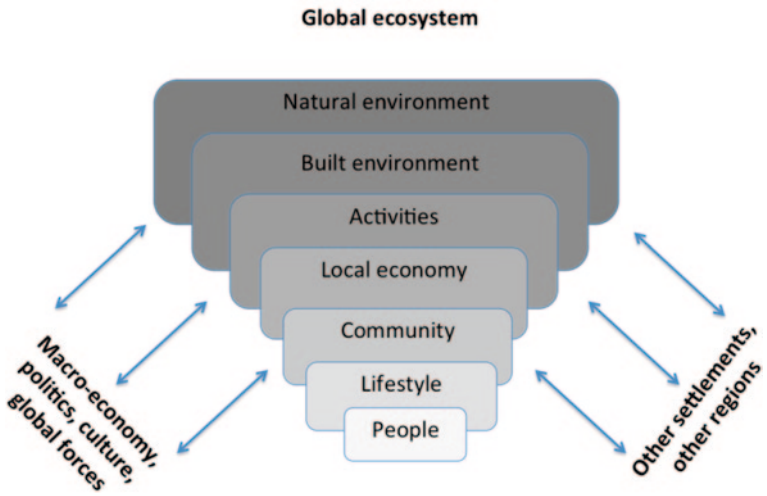

Fig. 3 The ecosystem model of settlements—determinants of health and well being. (Adapted from Barton and Grant 2006)

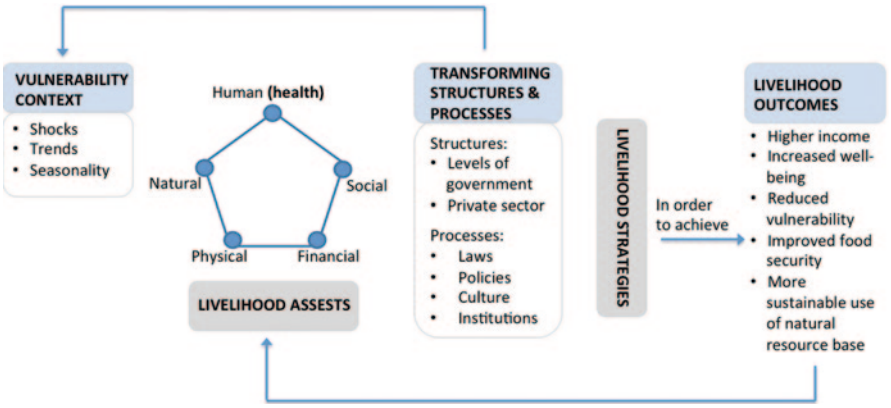

Fig. 4 Sustainable livelihoods framework as defined by UK Department for International Development (DFID 1999)

Livelihoods There are a variety of definitions but typically livelihoods are perceived as the capabilities, assets (including both material and social resources) and activities required for a means of living (Chambers and Conway 1992; Scoones 1998; DFID 1999). Livelihood strategies (i.e. the range and combination of activities and choices that people make in order to achieve desired livelihood outcomes) are influenced by the level and combination of the assets (or capitals) to which an individual has access (Fig. 4, Table 1). The sustainable livelihoods approach was developed as a way to improve understanding of the livelihoods of poor people. Again, various definitions have been proposed but most are similar to the following: *A livelihood is sustainable when it can cope with and recover from stress and shocks and can maintain or enhance its capabilities and assets, both now and in the future, while not undermining the natural resource base* (Carney et al. 1999).

Livelihood strategies can be conceived as the choices and activities individuals make to both accumulate and convert (i.e. switch) between different assets/capitals. For example, knowledge (human capital) can be used to earn money (thereby increasing financial capital) which in turn can be spent to improve education or health (human capital) or build shelter (physical capital). The manner in which different capital is accessed, transformed and accumulated is to a large extent dictated by the transforming "structures and processes" (i.e. the institutions, laws, policies etc.) that comprise human societies. Furthermore, the assets (particularly natural capital) available to people are to a large extent dictated by the environment in which they live. Past analyses of poverty have shown that peoples' ability to escape from poverty is critically dependent on their access to different assets (DFID 1999).

The livelihoods approach can be conceptualised as encompassing both the ecosystem services and human health concepts (Fig. 5). Health is incorporated within the livelihoods concept in two ways. First, since the ability to undertake livelihood strategies depends on it, health is a key component of human capital: people in

Table 1 Brief description of livelihood assets and other livelihood terminology. (Adapted from DFID 1999)

Human capital	Skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve livelihood objectives
Social capital	Social resources upon which people can draw in the pursuit of livelihood objectives. Typically social capital comprise networks, formal groups (i.e. operating through rules, norms and sanctions) and less formal relationships (i.e operating through trust, reciprocity and exchange)
Physical capital	Basic infrastructure (e.g. roads, shelter, water supply, electricity) and producer goods (e.g. tools and equipment) needed to support livelihoods
Financial capital	Financial resources that people use to achieve livelihood objectives
Natural capital	Natural resource stocks from which resource flows and services that are useful for livelihoods are derived
Livelihood strategy	The range and combination of activities and choices that people make/undertake to achieve their livelihood goals (including productive activities, investment strategies, reproductive choices etc.)
Livelihood outcomes	The achievements or outputs of livelihood strategies. Examples include increased income, increased well-being (including health status), improved food security etc.
Transforming structures and processes	The institutions, organisations, policies and laws that facilitate or constrain livelihood strategies and hence livelihood outcomes. They determine access to different types of capital, terms of exchanges between different types of capital and returns (financial or otherwise) to any given livelihood strategy

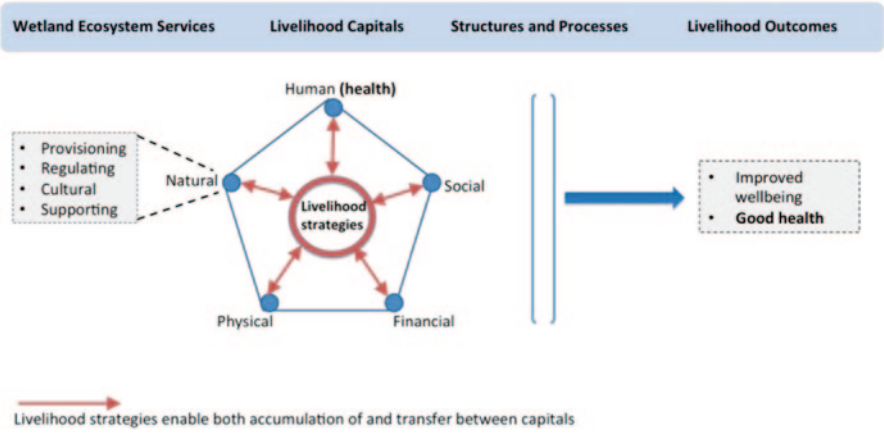

Fig. 5 A conceptual framework linking the concepts of wetland ecosystem services (natural capital), livelihoods and human health

poor health are not generally as productive as healthy people and this significantly constrains livelihood options. This is especially so for poor households in wetland dependent communities, where livelihood activities are often dependent on labour and there are fewer safety nets (Wetlands International 2010). Second, because "good health" is a fundamental constituent of human well-being, maintaining or improving health is frequently seen as a desired "outcome" (i.e. a key objective) of livelihood strategies. Thus, health is perceived as both an asset for, and an outcome of, livelihoods.

Wetland ecosystem services form an integral part of the livelihood strategy of wetland-dependent communities. The ecosystem services are, in the language of livelihoods, "natural capital". This natural capital is transformed into other livelihood assets including human capital (i.e. incorporating health) in a variety of ways. Natural capital can translate into health benefits directly. For example, through the consumption of nutritious wild foods or medicinal plants that may grow in a wetland. Natural capital can also translate into health benefits indirectly via other forms of capital. For example, wetlands often provide material (e.g. thatch and timber) that is used to build human shelters (i.e. physical capital) that contributes to human health by protecting people from the vagaries of the climate. Similarly, some wetland products may be sold and thereby converted to financial capital which in turn may be used to enhance health through the purchase of food or medicines. In some communities wetlands provide a space for community/religious activities that contribute to social cohesion thereby contributing to social capital which in turn may enhance peoples' general psychological well-being (i.e. their mental health). Thus wetlands may contribute to livelihoods and hence human health in a wide variety of ways. These interlinkages, which can be complex, are explored more fully in the sections that follow.

Wetland Contributions to Human Capital

Wetlands contribute to human capital and human health in a wide variety of ways. Perhaps the most fundamental is via the provisioning services that support basic human needs: water and food. However, other provisioning services, as well as regulating services and cultural services also play important role in enhancing and safeguarding peoples' well-being and health.

Water Supply

In locations where alternative water sources (e.g. groundwater) are scarce or dry at certain times of year, wetlands can provide water for drinking and domestic needs and also for livestock and irrigation (McCartney and Acreman 2009). In many places water abstracted directly from wetlands is essential for basic human survival. In places where water treatment facilities are unavailable, the health implications

of drinking this water are entirely dependent on the natural purifying processes occurring within the wetland. These processes include sedimentation, filtration, physical and chemical immobilisation, microbial interactions and uptake by vegetation (Kadlec and Knight 1996) (Box 1). The effectiveness of these processes vary considerably between wetlands and may be highly ephemeral due to the dynamic growth and metabolic processes within them (Wetzel 2001; Prior and Jones 2002). In wetlands with short residence times during the periods of maximum sediment and pollutant loading, the benefits may not be significant (McJannet et al. 2012). Furthermore, if pollutant loadings occurring naturally or, for example, arising from upstream agriculture, exceed the physiological tolerances of key microbial and/or plant species, degradation of the wetland will occur and effectiveness in terms of water purification is likely to decline (Gilman 1994). Effluents from industries, aquaculture ponds and domestic wastes from surrounding cities and villages may also drain into a wetland (Amarani et al. 2004), In such circumstances the health of people reliant on water from the wetland may be severely compromised.

Box 1: The filter function of the Nakivubo wetland (Source: TEEB 2010)

The Nakivubo wetland in Uganda acts as a natural filter for the effluent of the city of Kampala. Approximately 40 % of the sewage produced by the approximately 0.5 million residents of the city is discharged into the 5.5 km^2 wetland. The water from the wetland flows into Lake Victoria which is the primary source of the city's water supply. Evaluation has shown that the wastewater purification and nutrient retention services of the Nakivubo Swamp have an economic value of between US$ 1 and US$ 1.75 million.

Wild Food

Many wetlands support households through the provision of a wide range of "wild" foodstuffs, including plants, fish, birds and other animals. In the Bumwisudi wetland in Tanzania a range of wild fruits and wild vegetables are collected and eaten and in other wetlands water-birds and animals are hunted (McCartney and van Koppen 2004; Rebelo et al. 2009). Fishing, in the form of wild capture fisheries or aquaculture, is common in many wetlands, and can play a very important role in food security, not simply in terms of food provision but also in terms of vital contributions to nutrition through the provision of protein and micro-nutrients (Box 2). Wetland resources may provide the main livelihood support in periods when agricultural harvests fail completely or there is a shortfall. In the Lower Mekong Basin and many other places where people run short of food at critical times each year—so called hunger months—wetlands play a crucial role in coping strategies during periods of food shortage (Friend 2007).

Box 2: The invisible fishery of Southeast Asia

Throughout Southeast Asia, rice is the mainstay of peoples' diet. However, rice based ecosystems are not important for rice alone. They often harbor a highly diverse set of organisms that provide multiple benefits including pest control and maintenance of soil fertility as well as being an important food source in their own right (Roger et al. 1991). Some rice based ecosystems contain more than 100 species which are useful to rural communities

The vast majority of rural people in the Lower Mekong Basin harvest, consume and sell aquatic resources but only a small proportion could be considered "professional" fishers. For the majority fishing provides a way of diversifying livelihood activities and a safety net that can be relied on in the face of crop failure and other food shortages (Friend 2007).

In relation to food, the "catch" from rice fields is usually modest and only sufficient for a single day. Consequently, it often goes unnoticed in official statistics. However, this "invisible" fishery can be vitally important. In Laos, fish and other aquatic organisms, caught in rice fields and associated water channels, including amphibians, molluscs, crustaceans and insects, have been found to be vitally important for nutrition. They account for a large proportion of many people's intake of protein, micronutrients and essential fatty acids (FAO 2004).

Southeast Asian rice farmers often manage aquatic habitats and resources on their paddy land to increase the harvesting of aquatic animals which contribute to household nutrition and income. In a study to characterize the diversity of aquatic resources harvested from Farmer Managed Aquatic Systems in rice farming landscapes in Cambodia, Thailand and Vietnam. Amilhat et al. (2009) recorded farmers harvesting diverse self-recruiting species: 24 locally recognized species in Cambodia, 66 in Thailand and 17 in Vietnam. Fish accounted for the largest share by weight in all areas but frogs, snails, crustaceans and insects were also important. Amphibious species, well adapted to rice farming landscapes, dominated catches of both fish and non-fish self-recruiting species.

In some places, traditional rice fields have been cultivated sustainably for many hundreds of years. However, in recent decades as the human population has risen, pressure on rice ecosystems has also increased. Agrochemical use, sedimentation, habitat loss, destruction of fish breeding grounds and destructive fishing methods have all undermined the biodiversity of rice based systems. To feed more people increased rice production is essential. However, it should not be at the cost of the living aquatic resources on which so many people depend. Ways must be found to sustain changing human demands and simultaneously maintain the natural resources.

Agriculture

The needs of agriculture for flat, fertile land with a ready supply of water means 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 (Box 3). In Bangladesh many thousands of cattle that graze on floodplain wetlands during the dry season are watered from perennially flooded areas known locally as beels (Anonymous 1997). Such sources are particularly important where surface water storage by means of dams or tanks is beyond the capacity of traditional rural communities. It is recognized that agricultural activities can result in a change in the ecological character of a wetland and as well as bringing benefits can pose a risk to other important ecosystem services.

Box 3: The water resource opportunities provided by dambos for small-scale farming in Zimbabwe and Malawi (Source: McCartney et al. 1997; Wood et al. 2009).

In Zimbabwe, with its savanna climate, dambos (seasonally saturated wetlands) are estimated to occupy about 1.3 million ha. Populations have to cope with both seasonal and interannual shortages of water as a matter of course. Under such circumstances, wetland environments that retain water close to, or at the ground surface, represent a water reserve that can be used to bridge mid-season droughts and extend the length of the growing season. Consequently, the water resources of dambos are widely utilized as an alternative, or supplement to rain-fed agriculture. In the communal farming areas of Zimbabwe, many thousands of hectares are cultivated. Most often this takes the form of cultivation of maize, rice and vegetables in small gardens. The intensity of cultivation varies considerably, but in some communal regions an average of 30 % (actual values vary from 5–75 %) of dambo area is cultivated and in some instances this cultivation has been continuous for decades.

Although the importance of wetland agriculture, and its important contribution to livelihoods, is widely recognized, globally there is very little quantitative data on its extent. The global network of "Ramsar" sites (i.e., those wetlands designated as being of International Importance under the Ramsar Convention) currently contains 2170 sites covering more than 203 million ha. In both Africa and Asia, more than 90 % of these sites directly support human welfare in one way or another. In Africa, 68 % of them are listed as used for agriculture (including livestock), whilst the corresponding proportion in Asia is 51 % (Table 2). Since the majority of Ramsar sites are conservation areas such figures certainly under represent the percentage of all wetlands in these regions used for agriculture.

Table 2 Wetland use in Ramsar sites of International Importance in Africa and Asia (million ha in parenthesis). Database analysed 23/1/14

Wetland use	Percentage of sites	
	Africa	Asia
Agriculture (including livestock)	68 (82)	51 (11)
Fisheries/aquaculture	58 (80)	56 (11)
Wetland products	35 (58)	29 (7)
Domestic water supply	15 (18)	10 (2)
Recreation/tourism/conservation	53 (54)	73 (13)
Total (any of the above)	91 (89)	96 (16)

In another example of dambo linked cultivation, in Malawi, in the dambos of Mpika and Kasungu, investments in upland reforestation and soil and water management in the dambos increased water available to irrigate crops during the dry months of September to December. Consequently, yields increased between 30 % and 60 %, while the area under cultivation increased by some 10–50 %, depending on the wetland. These investments gave villagers enough to eat during the food scarce season from December to February and hence improved household nutrition (Wood 2009).

Spatial variations in soil and water properties make dambos difficult to utilize for large-scale agriculture but are exactly the features which provide opportunities for small-scale farmers. Wet patches mixed with dry soils mean working areas containing dambos as a single unit is difficult and generalized methods of large-scale farming are inappropriate. Attempts by European colonists in the first half of the twentieth century to drain dambos to produce uniform conditions resulted in rapid soil erosion, environmental deterioration and the drying out of dambos. However, at a small scale farmers in communal areas can use each part of the slope in a different way, thereby reducing the risks of crop failure. The use of dambos requires flexibility in approach because the extent of soil-moisture retention varies from year to year depending on the rainfall. In drier years sequential cropping may not be possible, while in wetter years although multiple cropping of greater diversity may be possible, waterlogging can be a problem. Indigenous farming practices that combine dry upland farming with wetland cultivation have adapted to this variability.

Medicine

The roots, leaves and bark of many wetland plants are used for medicinal purposes (Box 4). The efficacy of such remedies is likely to be highly variable but this is a direct contribution to human health. Health benefits will also accrue to individuals—not just those residing in or close to wetlands—through pharmaceuticals

manufactured from wetland organisms (i.e. fungi, bacteria and algae). The medicinal qualities of these are good examples of the continued value of traditional knowledge to health care today (Horwitz and Finlayson 2011).

Box 4: Wetland medicines in Lao PDR (Source: Elkington et al. 2009).

In the Bueng Kiat Ngong wetlands, in Lao PDR more than 240 species of plants, belonging to 180 genera in 80 families of vascular plants are used by traditional healers in medical therapy. Plants used include *Tinspora crispa, Desmodium lanceolatum, Orthoisphon stamineas* and *Vitex trifolia*. At least 15 species have not been previously reported for medicinal properties, suggesting that their use maybe unique to Laos.

Disaster Risk Reduction

By disrupting livelihoods, natural disasters (e.g. floods, droughts, earthquakes) present significant hazards to people and serious consequences for their health, including in the worst cases, loss of life. The health consequences of these disasters may be immediate or may arise over the long-term, as a consequence of damage to infrastructure, increased incidence of disease and/or loss of water and food sources. The wide range of ecosystem services provided by wetlands can help mitigate the adverse impacts in both the short-term and the long-term (Horwitz et al. 2012).

In the short-term, because of their role in the hydrological cycle some wetlands may mitigate the immediate physical impacts of water-related disasters and hence enhance health by lessening peoples' exposure to physical hazards. Patterns of flow emanating from wetlands are significantly modified by hydrological processes that occur both within the wetland and through interactions in their catchment (Bullock and Acreman 2003). In some instances, wetlands regulate flows: attenuating floods and maintaining flow during dry periods and droughts (Box 5). Some coastal wetlands (e.g. mangroves and coastal marshes) may act as a form of natural coastal defence: reducing erosion, attenuating wave impacts and reducing the height of marine storm surges (Box 6). The risks from natural disasters are likely to increase in coming decades as a consequence of global and regional changes that include increasing storm intensity, accelerating sea level rise and land subsidence (Temmerman et al. 2013), as well as changes in land cover.

Wetlands that reduce risks, such as those described above, contribute to human well-being and health by saving lives and alleviating the immediate hazards. However, it should be noted that effects on flow and storm surges are a function not just of the presence/absence of a particular wetland, but also of a range of other biophysical factors, including topography, climate, soil, vegetation and geology. Consequently, the immediate hazard-reducing functions of wetlands depend to a large extent on location-specific characteristics that make it very difficult to generalise. Furthermore, many wetland processes are dynamic so that the role wetlands play

may change over time: sometimes mitigating but sometimes enhancing the natural processes that cause hazards (e.g. floods). Hence, simple relationships between the areal coverage of particular wetland types within a catchment or along a coastline and the impact on flood flows/storm surges are generally not found (e.g. McCartney et al. 2013).

Box 5: River flood attenuation

Floodplain wetlands lying adjacent to river channels have been shown to attenuate floods by providing temporary upstream storage for water and reducing flow velocities. This phenomenon has been widely utilized as a means of flood control for many years. For example, controlled flooding of floodplain wetlands has long been used as a management strategy to protect the city of Lincoln in the UK (Wakelin et al. 1987) and 3800 ha of floodplain on the Charles River in the USA are estimated to save US$ 17 million in avoided flood damage each year (US Corps of Engineers 1972). Similarly, the flood protection role of the 20,000 ha That Luang wetland in Vientiane, Laos PDR has been estimated to be worth US$ 2.8 million per year (Gerrard 2004). Modelling studies on the River Cherwell in the UK comparing the flood reduction benefits of increasing the length of embankments or removing them altogether have shown that further embanking the river would increase flood flows by up to 150 % whilst restoring the floodplain to its pre-engineered configuration would reduce peak flow by between 10 and 15 % (Acreman et al. 2003).

Box 6: Coastal storm surge reduction by Mangroves

Storm surges caused by tropical cyclones are a major threat to low-lying coastal areas. Mangroves are widely perceived to reduce storm surge water levels by slowing the flow of water and reducing surface waves. Numerical simulations indicate that storm surge reductions range from 5 to 50 cm and wave height can be reduced by up to 75 % per kilometre of width of mangrove (McIvor et al. 2012). Modelling studies also indicate that the magnitude of energy absorbed depends on forest density, diameter of stems and roots, forest floor slope, bathymetry and the spectral characteristics (height, period etc.) of the incident waves and the tidal stage at which the wave enters the forest (Alongi 2008). However, there is very little statistically valid empirical evidence that mangroves have significantly reduced the human death toll of tsunamis. Studies following the 2004 Indian Ocean tsunami, indicated that the areas that suffered less were sheltered from direct exposure to the open sea (i.e. bays, lagoons, estuaries) and it was this, rather than the presence of absence of mangroves, which was the most significant determinant of damage and loss of life (Kerr et al. 2006; Chatenoux and Peduzzi 2007). Thus the role of mangroves in tsunami protection should not be overstated (Alongi 2008).

In the long-term, wetlands can provide sustenance and help people survive and recover from the impacts of natural disasters. For example, in the aftermath of a disaster, when damaged infrastructure and communication networks may make life difficult for survivors for long periods of time, the provisioning services of wetlands may supply the basic life support needs (e.g. drinking water, firewood, building materials and food). For example, the wetlands of the Mara River in Tanzania are used to grow food and are a major contributor to community coping strategies during times of extended drought (McCartney and van Koppen 2004).

Psychological Well-being

Many wetlands contribute to peoples' well-being directly but in intangible, non-physical, ways. Although there is little evidence specifically for wetlands, it is widely recognized that natural environments can contribute to spiritual enrichment, cognitive development and aesthetic experience. The sport and recreational opportunities provided by wetlands also improve lifestyles in places where livelihoods are not necessarily dependent on the wetland itself. All of these, so called "cultural services", contribute to human capital by contributing to psychological well-being (Horwitz et al 2012).

Wetland Contributions to Financial Capital

As people move away from a subsistence form of livelihood, financial capital is increasingly important (UNDP 2012). The need for money (e.g. to supply every day needs and for school fees etc.) often becomes a major driver of livelihood activities in wetlands. However, when monetary considerations come to the fore, modes of utilization are no longer influenced solely by the nature of the resources in the wetland: other factors, such as access to markets and changing demands in those markets, become significant. Furthermore, socio-economic differentiation within communities leads to substantial disparity in the utilization of the wetlands and the benefits derived from them (Box 7). The danger is that a focus on immediate short-term financial gain results in practices that are unsustainable in the long-term, ultimately undermining the ecosystem services on which livelihoods depend (Box 8).

Box 7: Social differentiation in benefits from the Kilombero Wetland, Tanzania (Source: McCartney and van Koppen 2004)

In the Kilombero wetland in Tanzania, people in the villages were traditionally fishers. However, in recent years, for a variety of reasons, there has been a significant increase in cultivation. The creation of national parks in the vicinity of the wetland has increased pressure on the wetland itself because villagers

access to other areas has been curtailed. At an aggregate level, the contribution of wetland cultivation to total income is 66% of the approximately US$ 518 per household per year. However, this average masks important differences across households. Poor households receive 80% of their average annual income (US$ 230) from the wetland compared to 48 and 70% for the intermediate (US$ 414) and better-off households (US$ 910) respectively. Dryland cultivation contributes 25%, 50% and 7% of total income from cultivation to the better-off, intermediate and poor households respectively.

Box 8: Over-exploitation of wild foods in Zambia (Source: Masiyandima et al. 2004)

Chikanda, a vegetarian meatloaf made from peanuts and the boiled tubers of orchids (genera: *Disa*, *Satyrium, Habenaria*, *Brachycorythis* and *Eulophia),* is a popular delicacy in Zambia and other countries in Southern Africa. At Mabumba wetland in Zambia, the harvesting of wild orchid tubers for both household diet and for sale is a common practice. Traditionally harvesting entailed digging out the whole plant, followed by removal of the tuber and replanting the stem to allow the plant to regenerate. However, in recent years orchids have been harvested in ever increasing numbers and harvesters tend to no longer replant the stems. Consequently, orchid numbers are reported to be declining as a consequence of these unsustainable harvesting practices.

By contributing to household incomes, the ecosystem services of wetlands contribute to livelihood financial capital in a variety of ways. This includes both the sale of wetland products and through other forms of income generation, for example wetland tourism (Box 9). There is considerable evidence that higher income is linked to better health both through a direct effect on material conditions necessary for biological survival (not least the ability to purchase food and health care) and through an effect on social participation and opportunity to control life circumstances (Marmot 2002).

Box 9: Livelihood benefits of tourism in the Okavango (Source: Mbaiwa and Stronza 2010)

Approximately 120,000 tourists visit the Okavango Delta in Botswana each year. This makes it one of the primary tourist attractions in southern Africa. A recent study of the effects of tourism development on rural livelihoods in three villages in the delta found that communities have foregone traditional

livelihood activities such as hunting and gathering, fishing, livestock and crop farming to participate in cash-based tourism related activities. This has included: the collection and sale of grass to safari companies for thatching lodges and camps, the production and sale of crafts, especially baskets and other wood carvings and beads to passing tourists and employment opportunities in community based natural resource management projects and safari companies in the Delta. In addition to individual benefits the communities as a whole also benefit from the sale of wildlife quotas (fees for animals hunted) and tourism fees (e.g. lodge and campsites). This income is used to fund social services and community development projects, including the installation of piped water to households and improvement of houses for the elderly and poor. As a result livelihoods have improved and, although health impacts were not evaluated explicitly, many local people reported improvements in overall well-being.

Wetland Contributions to Physical Capital

In many places wetlands contribute directly to physical capital through the provision of materials used for construction of both shelter and tools/instruments essential for livelihoods (Box 10). In many communities construction materials used for houses (e.g. grass for thatch and wooden poles) as well as agricultural tools (e.g. ploughs, axe handles, digging sticks) and household implements (e.g. bowls, baskets, food stores and water containers) have traditionally been manufactured from plants and other materials (e.g. clay) sourced from wetlands. In some instances clothes have been manufactured from wetland products. Thus wetlands can provide many of the basic necessities for supporting livelihoods and hence well-being/health.

Box 10: Wetland contributions to construction materials in Tanzania (Source: McCartney and van Koppen 2004)

In the Bahi wetland people from both the Bahi Sokoni and Chali Makulu villages collect natural grass (local name nkuruwili or kongoloare) for house thatching. From the Bumbwisudi wetland, tree species (local names—mkarati, mnazi, mdamdam, mpera, mgulabi, mzambarau and mikarafuu) are used for construction materials (i.e., for poles, furniture and thatching) and fuelwood. From the Buswahili wetland, women collect the papyrus reeds and use them for the manufacture of mats, which they sell for approximately US$ 0.5 each.

Wetland Contributions to Social Capital

Cultural Heritage

In many place wetland communities have developed customs, rituals and philosophies that are synchronic with and reflective of the natural rhythms of the wetland (Box 11). In such instances the wetland may be integral to community perspectives of the world, create a sense of place, and are important cultural heritage. Hence, wetlands can play an important role in enhancing the social cohesion (i.e. social capital) of communities, which turn enhances peoples' health by contributing to overall psychological well-being.

Box 11: The Lozi people on the Barotse floodplain

The Lozi people in western Zambia celebrate the flooding of the Zambezi with the Kuombokav ceremony. The name means "to get out of the water onto dry ground". Every year towards the end of the rainy season the Lozi people make a ceremonial move to higher ground. When the Chief decides that it's time to leave (anytime from February to May), all the people pack their belongings into canoes and the whole tribe leaves together. The chief in his barge with his family and a troop of traditionally dressed paddlers, in the lead. It takes about 6 hours to cover the distance between the dry season capital Lealui, and the wet season capital Limulunga. There the successful move is celebrated with traditional singing and dancing. This ceremony dates back more than 300 years when the Lozi people broke away from the great Lunda Empire to come and settle in the upper regions of the Zambezi. The vast plains with abundant fish was ideal for settlement but the annual floods could not be stopped, so every year they move to higher ground until the rainy season passes**.**

Institutions

Given the importance of the benefits derived from wetlands it would be surprising not to find institutions and management practices endemic to rural populations that utilize them. In the past indigenous practices (e.g. related to land tenure within wetlands or fishing rights) depended to a large extent on the ability of communities to make and defend management rules. This required effective and credible local authorities; typically traditional leaders who often derived authority from their ancestors (McCartney and Van Koppen 2004).

In recent decades, there have been radical socio-political transformations throughout much of Africa and Asia and many of the traditional institutions governing wetland use have become less effective. Increasingly institutions formed via

formal government statutes (e.g. village committees etc.) have "officially" taken over with varying degrees of success. In many places the reality is that institutions are evolving as hybrids of modern and traditional arrangements linked together in complex and fluid networks (Cleaver and Frank 2005). Nevertheless, whatever form they take, if local people have a role to play in resource management and derive benefits from the resources around them, these institutions represent an important form of social capital, that can contribute to peoples well-being and health by: (i) by safeguarding opportunities for the poorest in communities; (ii) ensuring more equitable distribution of benefits; (iii) reducing conflict; and (iv) fostering sustainability. Under the right circumstances they enhance both conservation and rural development thereby contributing to well-being and health. The decentralization of resource management to communities has the potential to simultaneously promote conservation and development (Blaikie 2006; Mbaiwa 2005; Taylor 2002) (Box 12).

Box 12: Establishing institutions to sustainably manage Mekong wetland resources (Source: Friend 2007)

Wetland resources are fundamental to the livelihoods and health of many people living in the Mekong basin. Ensuring that these resources and the people who depend on them are adequately represented in management and decision-making processes is critical for sustainability. In Vietnam, the Mekong Wetlands Biodiversity Conservation and Sustainable use Program (MWBP) supported the establishment of Natural Resource Management Groups (NRMGs) in the Tram Chim National Park and Lang San Wetlands Reserve. Prior to these groups being established the managing authorities viewed local people as the main threat to conservation and their principal objective was to keep local people from encroaching into the park. This approach aggravated conflict between the park authorities and local people and failed to reduce pressure on resources. The NRMGs were designed to promote dialogue between local people and park authorities with the ultimate aim of enabling co-management of the wetland resources. Resource Management Plans were developed that permit access to a designated 100-ha area of the park for members of registered NRMGs, but also provide specific guidelines on what resources can be used. For example, there are restrictions on the species of fish that can be caught and the mesh size of fishing nets.

The establishment of the NRMGs has been successful in building trust between the park authorities and local people. In other places the MWBP encouraged local administrations to recognize conservation zones in seasonally flooded forests in order to protect plants important for the production of traditional medicines. In yet other places, MWBP built on traditional institutional arrangements designed to conserve fisheries through the establishment of fishery conservation zones to protect fish spawning grounds and

the banning of destructive fishing practices. In many cases traditional management practices made special allowance for poorer households enabling them to use fishing gear for subsistence purposes that is otherwise banned and allowing to them to fish from community resources that are otherwise reserved for times of crisis (such as a death in the community) or a community celebration (such as a wedding).

Wetlands and Poverty

Poverty is, like livelihoods, a complex, multi-faceted phenomenon. One simple definition is "pronounced deprivation of well-being" (World Bank 2001a). Poor health is a common consequence of poverty and health is very often a key priority for poor people. For many, paying to treat health problems or losing household labour due to poor health (or the need to look after a sickly family member) can significantly undermine livelihood strategies and push households deeper into poverty. Therefore, improving nutrition and health can significantly improve livelihood productivity and reduce poverty.

For communities dependent on wetland resources, the ways in which ecosystem services integrate with other livelihood capitals are important in influencing poverty. Degradation or loss of wetland functionality often reduces the availability of food and other important services that support livelihoods. Consequently, wetland degradation and high levels of poverty often go hand-in-hand.

In a review of seven wetland case studies in Africa and Asia, the links between wetland degradation and poverty were clear (Senaratna Sellamuttu et al. 2008). However, whether poverty was a driver of wetland degradation or its result varied from case to case (Box 13). What is clear is that once wetland degradation began, a vicious spiral set in with one problem making the other worse with ever-deepening environmental degradation and poverty (Senaratna Sellamuttu et al. 2008). Modifying the ecological character of a wetland—deliberately or otherwise—can have a significant impact on livelihoods and poverty (Box 14).

Box 13: Wetland degradation and poverty linkages (Source: Senaratna Sellamuttu et al. 2008).

Poverty as a driver of wetland degradation

Lake Fundudzi which covers 144 ha is South Africa's only inland freshwater lake. Dependence on the wetland is high as the area's primary productive resource. The lake's fisheries are the main source of protein for the majority of households and its water is used to support livestock. In an attempt to improve food security, a large number of new commercial and smallholder

fruit orchards and vegetable gardens were established in the catchment and cultivated both in winter and summer. Poor land use planning resulting from fragmented institutions and poor awareness meant the clearing of natural vegetation for cultivation, and housing was haphazard and began to drive excessive lake sedimentation. This was exacerbated by cultivation on steep slopes without measures for soil-erosion control. Promoting participatory wetland rehabilitation and land use planning for sustainable land use to bolster local incomes thus became a priority.

Poverty as a result of wetland degradation

The Hadejia-Nguru wetlands constitute an inland delta in northern Nigeria, located where the Hadejia and Jamaare rivers meet in the Komodugu-Yobe Basin. The basin supports a population of 18 million, 1.5 million of whom reside within the wetland. The predominance of farming, fishing, livestock-rearing and collection of wild resources indicate a high dependence on the rich wetland ecosystems. Since 1971, a series of dams have been constructed on the main tributaries to provide water for cereal irrigation. Although the yields from intensive irrigation schemes are higher per hectare than from floodplain agriculture, the total value of wetland benefits exceeds that from the irrigation: US$ 167 ha^{-1} from the wetland compared to US$ 29 ha^{-1} from irrigated agriculture. Since the construction of the dams and irrigation schemes, drastic changes have occurred in the wetland. The flood extent has declined from 2000 to 413 km^2. Dam design and operation have altered both the volume and timing of water flow in the basin, subjecting some parts to prolonged flooding and others to prolonged drought. The resulting wetland degradation has undermined many key livelihoods and restricted access to infrastructure and services such as credit and markets. Livelihood failures severely aggravated poverty and resulted in abandoned villages and further ecological degradation as people exploited other natural resources to cope with the loss of primary production systems.

Box 14: Kolleru Lake—changes in ecological character affect livelihoods and poverty (Source: Senaratna Sellamuttu et al. 2012)

Kolleru Lake in Andhra Pradesh is one of the largest freshwater lakes in Asia. As well as being a vital habitat for birds (189 bird species have been recorded), it has a long history of human use and conflict. Recent changes to the use of the lake demonstrate the challenges of establishing and maintaining wise use of the wetland amongst many competing demands.

During the 1990s, the Indian Government promoted intensive food production– mostly rice and aquaculture—in the lake, which had previously been

used for traditional capture fisheries and as source of drinking and domestic water. The change was partly a response to food shortages in the region, but also to realize the wetland's economic potential through selling fish to other parts of India, such as Calcutta. However, much of the aquaculture was taken over by outside business interests, meaning that there was creation of some local employment but only a small proportion of the total income generated benefitted local people.

The intensive aquaculture also caused several problems. The nets and fishing traps set on the lake blocked the entrance to it. Kolleru Lake acts as a sink for storm water, and this obstruction led to serious flooding in farms surrounding the wetland. Water quality in the lake also deteriorated rapidly as consequence of pollutants from the aquaculture as well as effluents flowing into it from the intensive rice farming, in conjunction with domestic and industrial sewage, essentially eliminating the local communities' access to safe drinking water. The water, sediment and fish from the lake became contaminated with pesticides, polycyclic aromatic hydrocarbons and heavy metals (Amarani et al. 2004). Local people were compelled to purchase drinking water from traders due to the inability to use the water from the lake for drinking purposes

At the same time, conservation groups were lobbying for Kolleru Lake to be designated a wildlife sanctuary to protect its resident and migratory bird populations. After a series of legal challenges, both in favour of the designation and objections by users of the lake, part of the lake was established as a sanctuary in 1999. Local communities lost access to traditional lands through the establishment of the protected area, over which the government assumed ownership. Despite this protection, encroachment by users of the wetland resulted in continued degradation of the ecosystem, and declining bird populations. In 2005, following further legal challenges from both sides, the aquaculture ponds were cleared from the protected area. This affected the livelihoods of local communities, many of whom were extremely poor. Destruction of the aquaculture ponds reduced the occurrence of flooding but compensation for the loss of aquaculture was slow to arrive and limited. The government provided little support for new livelihoods and so many people remain entrenched in poverty.

The sustainable livelihoods approach provides a holistic framework for analyzing the objectives, scope and priorities of progress towards poverty elimination and avoids focus on individual aspects of poverty. The ecosystem services concept provides a complementary perspective that illustrates the multiple and interconnected benefits which wetlands provide. Livelihood systems interact with wetlands across a range of spatial and temporal scales, often shaping and modifying ecosystem services. Clearly, strategies for poverty alleviation should be cognisant of wetland ecosystem services and the role they play in the livelihoods of the poor. However,

as discussed in the introduction to this chapter, not all drivers and constituents of poverty are addressed by simple provision of wetland ecosystem services. A wide range of options need to be considered to lift people out of poverty (Ramsar, Resolution XI.13 (2012).

Conclusion

Throughout much of the developing world near-natural wetlands represent a significant proportion of the landscape and continue to be places where many people live and derive their livelihoods. Hence, wetlands provide the settings for the livelihoods and health of these people. However, because wetlands are diverse, dynamic and multi-functional environments the way in which they interact with peoples' livelihoods, and hence influence their health, are intricate and complex. As the examples in this chapter have illustrated, the extent of livelihood dependence on wetlands and hence the demands on wetland ecosystem services are highly site specific and influenced by a myriad of biophysical, social, economic and cultural factors.

For many people, wetlands are the basis of food security and nutrition, drinking water and many other tangible and intangible benefits that impact their health. Some health benefits are derived directly from wetlands (e.g. medicinal plants) but, in common with all forms of natural capital, many others are only enabled by switching the natural capital afforded by wetlands to other forms of livelihood capital. However, wetlands do not exist to benefit people and some functions of wetlands (e.g. providing breeding habitat for mosquitoes that transmit malaria and snails that transmit schistosomiasis) can harm health and livelihoods. From a human perspective the "efficacy" of services varies considerably between wetland types, within a single wetland type and even, spatially and temporally, within a single wetland.

It is now widely recognised that economic development is necessary but not sufficient for poverty reduction. There is the risk that by degrading and undermining the productivity and sustainability of wetlands, strategies intended to increase economic benefits can in fact undermine the natural capital on which the poorest and most vulnerable depend. Support to livelihoods is not necessarily directly congruent with conservation objectives but there can be significant livelihood and health implications of getting the balance between conservation and development wrong.

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