# EVIDENCE NOTE

Agroecology TPP

#1

# Water and aquatic foods in the 13 agroecological principles

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# EVIDENCE NOTE #1

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Agroecology is a holistic approach that aims to influence not just food production but food systems in their entirety. Water and aquatic foods are crucial for food security and nutrition and are key elements within agricultural and food systems. In 2019, the UN Committee on World Food Security (CFS), High Level Panel of Experts (HLPE) on Food Security and Nutrition identified 13 agroecological principles,[1] while in 2014 it had issued a report on sustainable fisheries and aquaculture for food security and nutrition.[2] We bring perspectives from these two HLPE reports together, and bring them up to date, in this evidence note that explores the role of water and aquatic foods in the transformation of food systems through agroecology.

To do this, we examined the current 13 HLPE agroecological principles to better understand whether and how they reflect the crucial roles of water and aquatic foods within food systems. For each principle, we drew from literature and experience to describe the relevance of water and aquatic foods in relation to the principles and practical examples of how water and aquatic foods are impacting food system transformation through agroecology (Table 1).

We found that only the principle of Synergy directly mentioned water. There were no direct references to aquatic foods. Noting that the lack of reference to water and aquatic foods could limit their integration in future agroecological initiatives, we suggested rephrasing of six principles to directly incorporate water, aquatic foods, and the actors that use and manage these resources. In October-November 2023 an e-consultation on the rephrased principles was conducted through the TPP. Feedback from respondents and from two anonymous reviewers in a peer-review process were used to further refine the rephrased principles (Table 2). In our perspective article in Nature Food (Freed et al., 2025) we explain how due consideration of these aspects could facilitate proper recognition of the land-to-seascape potential of agroecology as well as the people involved in aquatic food production and consumption.

1 HLPE. 2019. Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome. www.fao.org/3/ca5602en/ca5602en.pdf

2 HLPE. 2017. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome. www.fao.org/3/i3844e/i3844e.pdf

**Table 1. Presence of water and aquatic foods in the 13 agroecological principles**

| Principle | Water | Aquatic foods | Examples |
|---|---|---|---|
| **Recycling** | Water is a renewable but also variable and limited resource that is essential for all forms of agriculture. In many places, increasing and multiple demands on water resources (surface and ground water) mean that water management is crucial to ensure adequate and equitable utilization in agriculture and other sectors (Qin et al., 2019) and mitigation of water risks.<br>Evaporation from water bodies (rivers, wetlands, lakes, ponds and reservoirs) typically represents a significant flux of water from landscapes (Fuentes et al. 2020). | Aquatic plants, animals, microalgae, and microbes play important roles in nutrient and carbon recycling (Kabir et al.,2020 Vanni 2002, Wilson and Xenopoulos, 2011).<br>In addition to land and freshwater-based recycling, nutrients from agricultural runoff have been shown to be recycled through algae and bivalve mariculture (Gentry et al., 2020). | Nutritious pond feeds (Kabir et al.,2019).<br>Integrated multi-trophic aquaculture (Nederlof et al., 2021). |
| **Input reduction*** | Water is sometimes free (e.g. rainfall) and sometimes a directly or indirectly purchased input (i.e. irrigation). Irrigation and water-use efficiency at farm and landscape scales in part determine how much water remains available for the environment and other uses. However, increasing irrigation efficiency does not automatically increase water availability for non-agricultural uses and the environment (Lankford and McCartney, 2022; Uhlenbrook et al., 2022). | Aquatic production can include phytoplankton to improve nutrient availability, fish and other aquatic animals to reduce pests (Berg et al. 2012; Bosma et al., 2012).<br>The sediment from aquatic production systems such as fish ponds can be used as fertilizers (Haque et al., 2016; Drozdz et al., 2020). | Complex rice systems in Indonesia (Khumairoh et al., 2019).<br>Rice-fish system in Madagascar (Mortillaro et al., 2022) |
| **Soil health** | Soil moisture is a function of rainfall, water application, infiltration and evaporation.<br>Water quality influences the growth of plants and organic matter.<br>Flood water can contribute nutrients and sediments to croplands and grazing land. Soil health can decrease in agricultural areas that have been engineered to prevent inundation (Chapman et al., 2016).<br>Agricultural water management can help to conserve soil quality and downstream water quality, such as by preventing agrochemical and nutrient runoff and by encouraging infiltration to groundwater (Blann et al., 2009; Steenvoorden and Bouma, 1987; Libutti and Monteleone 2017). | Both natural and intensified aquatic systems have effects on soil and sediment health and water quality. The effects can range from benefits such as providing soil nutrients and recycling of aquatic nutrients, to harmful effects such as eutrophication and soil salinization. Water quality and soil and sediment health shape the productivity and diversity of aquatic food systems. | Silvofisheries model in Indonesia (Musa et al., 2020).<br>Environmental effects of shrimp culture in the Mekong Delta and Bangladesh (Be et al 2008; Kabir et al 2015; Chowdhury et al. 2011).<br>Effect of fish polyculture on benthic fauna in rice-fish system (Frei et al. 2007). |
| **Animal health** | Farm and pasture animals require access to unpolluted water at all times. Water is also needed to provide fodder and feed, including for aquaculture.<br>Aquatic connectivity and unpolluted, diverse aquatic habitats are required for many aquatic animals. | Approaches for aquatic animal welfare lags behind the growth of the aquaculture sector (Franks et al. 2021). | Water use for livestock in Ethiopia (Sileshi et al., 2003);<br>Welfare standards for aquatic foods (Stien et al. 2020). |

| Principle | Water | Aquatic foods | Examples |
|---|---|---|---|
| **Biodiversity** | Many species live and depend on aquatic ecosystems. Freshwater ecosystems (e.g. rivers, lakes, and inland wetlands) cover less than 1% of Earth but host 10% of all species and one-third of vertebrates (Strayer and Dudgeon 2010). Quantities and timing of water fluxes and water quality must be maintained to safeguard aquatic biodiversity and associated ecosystem services (e.g. water provision, risk mitigation, fisheries) which are critical for the livelihoods and well-being of many smallholders. This includes agricultural water management (Tickner et al., 2020). | This includes aquatic biodiversity in both marine and freshwater environments.<br>Landscape level approaches to maintaining biodiversity include animals that migrate between different habitats (both spatially and temporally), these approaches require maintenance of habitat diversity and aquatic connectivity across habitats (Tickner et al., 2020). | Biodiversity in rice field fisheries (Freed et al., 2020b). |
| **Synergy** | Water is not only a constituent of agroecosystems, but many biophysical processes depend on it (fluxes and stores). For example, water and carbon cycles are coupled so GHG emissions are a function of hydrological processes and can be influenced directly and indirectly by water management practices (Ward et al., 2017). | Reservoirs behind large dams can, in some circumstances, sustain significant fisheries.<br>Synergies in agroecosystems also include terrestrial-aquatic interactions. The complementarity of species and ecosystem elements can enhance synergy within micro-habitats/farm plots and across the ecosystem more broadly. | Cahora Bassa and Kariba dams on the Zambezi River; McCartney and Nyambe, 2017).<br>Forests and freshwater fisheries in Nigeria (Lo et al., 2019)<br>Integrated rice and aquatic foods agroecosystems (Freed et al., 2020a; Mortillaro et al., 2022). |
| **Economic diversification** | Rainfed production systems are vulnerable to both natural and human-induced variability; both floods and droughts can adversely impact production. Agricultural water management practices such as rainwater harvesting and irrigation can increase water availability at critical times and enable food producers to diversify. | Engaging in aquatic food production can diversify income portfolios, contribute to food security and nutrition, and enhance community resilience. Aquatic food production can provide income opportunities for both landholders and landless. However, it is important to consider economic implications, such as increased risk for small scale producers when diversifying into intensified or commercially driven aquatic food value chains (Kaminski et al 2020). | Fisheries in rice farming areas (Hortle 2008).<br>Community Based Fisheries and Aquaculture as a collective approach to economic diversification (Haque and Dey 2017).<br>Aquaculture for landholders and landless (Belton et al. 2014). |
| **Co-creation of knowledge** | Typically, food producers' knowledge about both surface and ground water management has developed over many generations (Rivera-Ferre et al., 2016). They can share their knowledge with other practitioners through learning exchanges.<br>Integrating scientific disciplines, such as hydrology, aquatic ecology, marine sciences, and freshwater ecology can contribute to the agroecological knowledge base. | Food producers are essential in the co-creation of knowledge in aquatic food systems, which can inform agroecological innovation.<br>Breaking silos between crops and aquatic foods (e.g. Atkins et al. 2020, Freed et al. 2020a), and between wild and farmed foods (e.g. Tezzo et al. 2021b, Freed et al. 2020a) is part of co-creation, especially when actors are part of the same agroecosystem. | Community Fish Refuge management and learning exchange (Kim et al. 2019). |

| Principle | Water | Aquatic foods | Examples |
|---|---|---|---|
| **Social values and diets** | Water is a key component in all food production systems. These food production systems are shaped by the environment, culture, identity and political structures. Sometime water is a critical component of cultural identity.<br>Adequate water of good quality is an essential component of a healthy diet. | Fishing can be a unifying activity that builds relations between individuals and groups, it can also build a shared identity (Allison et al., 2020).<br>Food systems that incorporate aquatic foods can provide local, diverse, and nutritious foods and can ensure that social values and diets contribute to individual and collective well-being. While some studies emphasize a nutrition transition that occurs as populations urbanize, more traditional and nutritious diets can continue when connection to cultural roots is a social value and access to traditional foods is maintained.<br>A diversity of aquatic foods is foundational to diets in the Mekong and other regions. | The Lozi people of the Barotse floodplain in western Zambia celebrate the annual (rejuvenating) flooding of the Zambezi (Namafe 2004). The Sama-Bajau in Southeast Asia are a nomadic marine-dependent ethnic community (Stacey et al., 2018).<br>Aquatic foods are prominent in social values and diets in many countries (Freed et al., 2020b; Garaway et al., 2013; Tezzo et al., 2021a; Tvedten 2002), especially in Indigenous communities globally (Cisneros-Montemayor et al., 2016). |
| **Fairness** | Irrigation (a key component of the Green Revolution, irrigated area has approximately doubled in the past 50 years; Foley et al. 2011) can contribute to both food security (SDG2) and poverty alleviation (SDG1). Many smallholder farmers see irrigation as their most preferred but not implemented climate change adaptation strategy (Bryan et al. 2013). Farmer-led irrigation development is increasingly seen as a practical, more sustainable alternative to large-scale, typically government led irrigation investment and, if managed correctly, more likely to be inclusive and equitable.<br>However, data on equity in irrigation schemes and technologies, including farmer-led ones, are sparse. The few studies available indicate that young, better-off men tend to benefit most and that there is little movement towards more equitable access (Lefore et al., 2019, FAO 2023).<br>Crop selection can also affect fair distribution of water for agriculture (Mahdi et al., 2024) and should be considered in agroecological approaches.<br>Global inequities in water footprints and resulting localized challenges in water security and climate resilience were recognized through the Glasgow Declaration for fair water footprints (COP26). | Agricultural development can mean trade-offs in availability and access to fisheries and aquatic foods, these values and their social dimensions need to be incorporated from the start of agricultural planning and investments (Duncan et al., 2021).<br>Fair wages and working conditions of fishers are an ongoing challenge. Within the small-scale fisheries sector, key actors continue to address fairness, viability, and sustainability issues. | Farmer-led irrigation development in Africa (Woodhouse et al., 2016; World Bank 2021; Harmon et al., 2023).<br>Voluntary guidelines for securing sustainable small-scale fisheries (FAO, 2015). |

| Principle | Water | Aquatic foods | Examples |
| --- | --- | --- | --- |
| **Connectivity** | Water is a systemic connector, linking ecosystems, sectors and economies together. Hydrological processes control ecosystem functions and water is the medium through which many climate change impacts will be felt (Sadoff and Muller 2009). Food system resilience and sustainability must be managed in the context of integrated land and water systems.<br>In many places increasing competition for water (e.g. from the domestic and industrial sectors), as well as the critical role of water in ecosystems, means increasing water-use efficiency is a pre-requisite for future sustainable agriculture. | Aquatic foods are not always accessible to local populations (Hicks et al., 2019). To meet local nutritional needs and achieve food security, one pathway is re-embedding food systems (including fisheries) into local economies.<br>Conversely, in many cases the importance of aquatic foods for diets and incomes is undervalued due to the use of alternative modes of distribution/ procurement that are unaccounted for (Allison and Mills, 2018). | Examining consumer social movements through the lens of seafood (Olson et al., 2014). |
| **Land and natural resource governance** | Because of its multifaceted nature, water governance – the political social, economic and administrative systems that influence the use and management of water – are typically complex, spanning geographic and temporal scales, political jurisdictions and public and private sectors. Many decisions made outside the formal water sector (e.g. in energy, manufacturing, mining and food/agriculture) and outside the sphere of control of small-scale food producers influence the way water is used, who gets what water, when and how, and who has the right to water, its related services and their benefits. The OECD has published 12 principles for the governance of water and developed a Water Governance Indicator Framework which aims to promote equitable use and manage trade-offs across water users (OECD, 2018). | Small-scale fishers who are closely connected to the aquatic system can be key contributors in sustainable management of aquatic natural resources (FAO 2015; d'Armengol et al. 2018). However, they also have limited ability to govern resources and processes across large spatial scales, for example migratory populations of aquatic species and nutrient flows, which require coordination of many actors (Loring 2023). Considering the other agroecological principles of participation, fairness, and co-creation of knowledge, the agroecological approach to land and natural resource governance emphasizes stewardship, pluralism, interactions across actors and institutions, adaptive management, and includes indigenous and traditional forms of management and the protection of ecosystem functions and services (Berkes 2010). Inclusive governance and means of access to production are essential to strengthening the resilience of food systems for all. | Local collective action to manage water resource systems in Bangladesh (Afroz et al., 2016).<br>Fishers' roles in resource governance (Campos-Silva and Peres 2016; Freed et al., 2016; Kura et al., 2023).<br>Impact of community- based fish culture in Bangladesh (Haque and Dey, 2016).<br>Adapting water governance institutions to context (Meinzen-Dick, 2007). |
| **Participation** | In most places Water User Associations (WUAs) or Water User Groups (WUGs) provide an institutional mechanism critical for representation of beneficiary farmers in the governance of irrigation schemes. In many countries, governments have devolved local decision-making responsibilities to these groups in order to apply subsidiarity in water management. However, lack of capacity is a major constraint. To ensure that WUAs/WUGs are more effective, a focus on increasing participation in initial design and a more context appropriate approach to WUG formation is needed. | A variety of local and traditional fisheries management arrangements that empower fishers have been observed to both meet fishing communities' needs and minimize conflict (Castello et al., 2008; Freed et al., 2016). However, more could be done to engage fishers in the shaping of food system policies, which are often designed in a way that at best ignore and at worst undermine the benefits gained through small scale fisheries (Arthur et al., 2021). | Water user associations in Sub Saharan Africa (Aarndouse et al., 2018). |

***** = principle undergoing revision through a separate process.
****** = includes fishers, pastoralists and other livestock keepers, hunters, foragers.

**Table 2. Rephrasing six of the 13 agroecological principles to explicitly incorporate water and aquatic foods**

*Proposed revisions are* **in bold**.

| Principle label | Statement of the principle |
|---|---|
| **Recycling** | Preferentially use local renewable resources and close as far as possible resource cycles of nutrients, biomass, **and water** |
| **Soil health and water resources** | Secure and enhance soil health **and water resources to ensure i)** functioning for improved plant **and aquatic animal** growth, particularly by managing organic matter and enhancing soil **and substrate** biological activity **and ii) adequate quantity and quality of water for both in-situ food production and downstream biodiversity and ecosystem services** |
| **Biodiversity** | Maintain and enhance diversity of species, functional diversity, and genetic resources and thereby maintain overall agroecosystem biodiversity in time and space at field, farm and landscape scales **encompassing terrestrial, aquatic, and marine environments** |
| **Economic diversification** | Diversify **farmer and other food producers'**** incomes by ensuring that **producers at small to large scales of production** have greater financial independence and value addition opportunities while enabling them to respond to demand from consumers |
| **Co-creation of knowledge** | Enhance co-creation and horizontal sharing of knowledge including local and scientific innovation especially through **farmer-to-farmer and other food producers**** exchange |
| **Land and natural resource governance** | Strengthen institutional arrangements to improve **governance and its coordination across scales and between large- and small-scale users**, including the recognition and support of family farmers, smallholders, peasant food producers**, **and community or producer associations***** as **rights-holders and** sustainable managers of natural and genetic resources |

** = includes fishers, pastoralists and other livestock keepers, hunters, foragers.
*** = including, but not limited to, community natural resource management associations, water-user associations, forest user groups, fisher associations, Indigenous Peoples.

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# EVIDENCE NOTE

# #1

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The Agroecology TPP **Evidence Notes** are supplementary documents developed to enhance the accessibility and impact of scholarly research. Designed to accompany journal articles, they distill key arguments, clarify complex concepts, and foreground critical evidence in a concise and structured format. By providing a synthesis of core contributions, our Evidence Notes support knowledge translation across academic, pedagogical, and policy contexts, enabling readers to engage more readily with the substance of a publication.

This evidence note is in support of the journal article:
Freed, S., Lo, M.G.Y., McCartney, M. *et al.* Water and aquatic foods in revised principles of agroecolo-gy can accelerate food systems transformation. *Nat Food* (2025).
DOI: 10.1038/s43016-025-01152-9

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**About the Agroecology TPP**

The Agroecology TPP convenes a broad group of scientists, practitioners and policymakers working together to accelerate agroecological transitions. Since its official launch on 3 June 2021, the TPP has begun addressing knowledge gaps across eight domains that will support various institutions and advocacy groups in key decision-making processes. Its online COMMUNITIES are open to all, providing spaces for members to co-create knowledge, share insights and experiences on various agroecological themes, building collaborative networks with local communities and research bodies to drive agroecological progress for food systems transformation.