The groundwater restoration

Lively discussion between farmer and researchers, standing at the haveli dyke at the start of the second cropping season.

Photo: World Agroforestry/Meine van Noordwijk

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CHAPTER ELEVEN

Public co-investment in groundwater recharge in Bundelkhand, Uttar Pradesh, India

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Highlights

- Co-investment of public funds in a critical ecosystem (ES) can have substantial social welfare multipliers
- Explicit resource management at landscape scale based on common understanding is essential
- Land-use rights in the area used for rainwater harvesting need further attention
- 'Mainstreaming' tree domestication requires appropriate links with 'demand' and market structures

11.1 Introduction

The 880 mm of rainfall that the landscape around Jhansi (India) receives in an average year easily allows for one cropping season. In the long dry season, however, life becomes difficult in the rural areas and the wells used for irrigating a second crop rapidly dry up, so only a small part of the land can be cropped twice. Many people look for seasonal jobs in cities in this period, as even drinking water becomes hard to obtain, while the livestock roams around freely to feed on whatever biomass it can find. This practice of abandoning cattle is known as *annapratha* locally.

In the dry years from 2004 to 2007 and in 2014, 2015 and 2016, more than 80% of open wells dried up soon after the monsoon season. Water scarcity due to frequent dry spells in the rainy season resulted in poor productivity, with crop yield ranging between 500–1000 kg/ha for major cereals, pulses and oil seed. Moreover, as water for domestic use is traditionally collected by women and at large distances from home, school attendance is low.

In the cities, there is water from a large reservoir fed by the surrounding landscapes and the rivers that flow in the rainy season. Would it be feasible to retain more of the water in the landscapes themselves, fully recharging the groundwater that can be stored above the impermeable granite substrate? In fact, as elsewhere in India [1], there have been water harvesting structures (*haveli*) here in the past that helped achieve this by flooding a part of the land during the rainy season. This temporary pond also captured sedimentation from incoming surface flows, creating a fertile soil ready for a good second crop after the water was drained.

A watershed rehabilitation program facilitated by the Indian Council of Agricultural Research-Central Agroforestry Research Institute, Jhansi in India (ICAR-CAFRI) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) tried to make a difference in the Parasai-Sindh watershed, where nearly 3000 people (with their cows, buffalos, goats and sheep) live in three villages on 1246 ha, in the ways sketched above. From 2012 onwards, the local community, supported by ICAR-CAFRI, ICRISAT, and the Jhansi district administration started implementing watershed interventions in this area. By restoring the *haveli* to create an additional water reservoir that allowed groundwater recharge, and a series of checkdams to slow down streamflow, the project managed a substantial increase in water availability for a second growing season plus a year-round domestic water supply.

Figure 11.1 Location of the Parasai-Sindh watershed and its *haveli*, relative to Jhansi city and its reservoir

The value of the ecosystem service of groundwater recharge can hardly be overestimated, as the social multipliers (see below) proved to be substantial. Sustainability of the success, however, will depend on the social as much as on the technical aspects. For the land owners in the *haveli*, some form of compensation is needed that was not foreseen in the initial watershed management plan. Could a form of payments (PES) emerge to have the downstream beneficiaries of the groundwater recharge help offset those who lost a crop upstream? Or is a form of co-investment, led by the public sector an appropriate long-term solution? In this brief summary of the very complex and rich case [2], we focus on A) the water balance of the area before and after the intervention, B) the subsequent changes in land use (including the shift to agroforestry (fruit and timber trees), C) the social multipliers on the ES value generated, D) those (potentially) losing out in the *haveli* and the managers of the downstream reservoir, before E) discussing the co investment (or PES) options.

11.2 Positive impacts of tree domestication

The technical interventions involved a series of checkdams on the main streams, with a joint storage capacity of 115,000 m^3(9 check dams; 3 gulley plugs, 1 *haveli* renovation, 1 community pond, 1 farm pond). The *haveli* harvests water from about 51 ha and involves a temporary pond of about 8 ha. The checkdams and other impoundments keep the equivalent of roughly 20 mm of surface runoff (i.e. 250,000 m^3 in two fillings) in the landscape, recharging groundwater. The groundwater table increased on average by 2.5 m, varying from 2.0–4.0 m according to toposequence position [3]. This additional water has increased cropping intensity as nearly 150 ha of fallow land were brought under cultivation and even increased crop yields by 30–50% during the post-monsoonal season, when crops require 250–350 mm of water, 100–150 mm of which is met by supplemental irrigation.

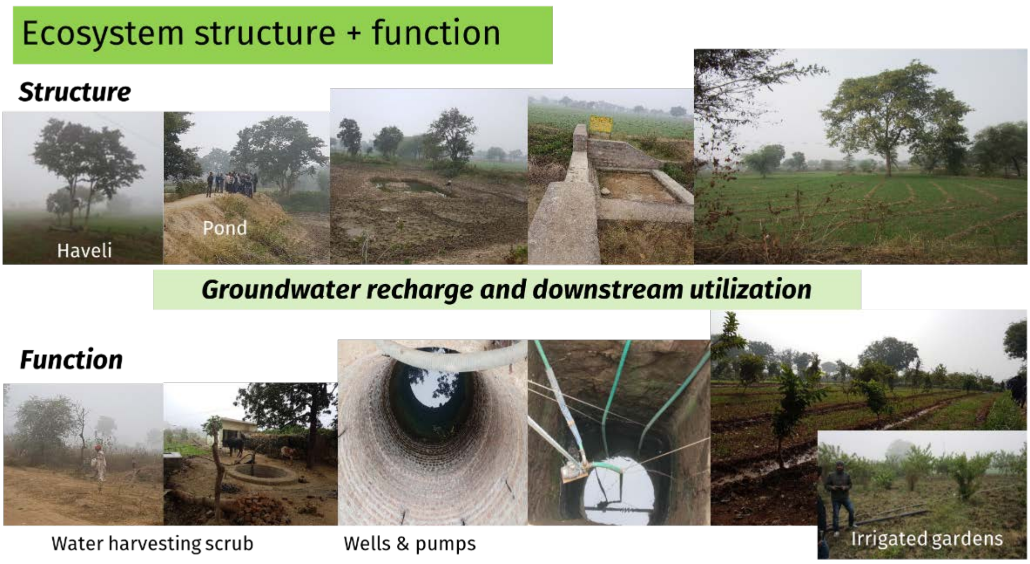

Figure 34.2 Elements of the modified water capture system at sub-watershed scale

11.3 Land-use consequences

The additional water supply not only allowed a substantial increase in the area that can be cropped twice a year, but also allowed a shift to the use of perennials, including fruit trees such as guava, citrus, and pomegranate as well as timber species. The livestock population increased substantially, especially buffaloes, which are used locally as a source of milk and are readily sold to Jhansi city.

11.4 Social benefit multipliers

Several social multipliers made that the human benefits derived from this change in ecosystem structure and function went beyond the 'provisioning' service of additional food production. The second cropping season stemmed the seasonal (poverty-driven) migration to look for urban jobs in the dry season. The landless people in the watershed can now find agricultural employment. Availability of well water meant that girls can now attend schools. Social capital and sharing of water resources for domestic use increased.

Figure 11.3 Human benefits from the increased groundwater availability included increased school attendance by girls and reduced dry-season migration to towns by the poorest segment of the population

11.5 Keeping all stakeholders engaged

Yet, not all stakeholders have been the winners. Two groups specifically perceive that they lost out. The first group are the farmers who own the land now ponded in the wet season by the *haveli*. They essentially lost their wet-season cropping opportunity. At the start of the program, they asked for financial compensation, but this was not provided for by the project, as it was seeking long-term sustainable solutions and no direct way of generating recurrent compensation was deemed feasible. Instead, the water management committee explored alternatives, such as investing in the creation of a fishpond downstream of the *haveli*, to be used by the *haveli* farmers and providing them with a direct incentive to secure year-round water supplies.

During a recent visit to the site as part of a training on ecosystem services in agroforestry, the *haveli* farmers asked to develop additional dams within the *haveli*, shifting the primary water harvesting structures to the shallower and less fertile soils of the upper catchment. This proposal will be further evaluated by the local water management committee with the support of ICAR-CAFRI researchers.

A second stakeholder group that is losing out, but so far not yet articulating demands, are the managers of the large reservoir that previously harvested water from the Parasai-Sindh watershed, only to find that a quarter of the rainfall is used for crop and tree evapotranspiration. So far, the argument that they will also ultimately benefit from more base-flow may have sufficed, but if all their catchments would follow the Parasai-Sindh example, further discussions on complex rights issues are likely to follow. It seems likely that pre-human natural vegetation used as much water as the current hydrologically restored subcatchment does, but the reservoir and its water users have had the benefits from the area becoming an effective 'rainwater harvesting' domain.

11.6 Discussion: the public business case for co-investment

The case demonstrates that, from a public policy perspective, there is a clear business case for the investments made, which apparently stayed within the norms the Government of India has set for projects. Rather than financial transfers within the community to compensate *haveli* farmers, alternative investments were explored, such as a fishpond which would create a clear benefit linked to water storage.

Enhancement of the ecosystem service of groundwater recharge (W3 in the scheme presented by Lusiana et al [4]) has clearly had human beneficiaries, with considerable social benefit multipliers. Government resources were combined with local agreements to use communal land for an additional reservoir and communal labour to physically reshape the hydro-ecological infrastructure. In this way, it qualifies as a co-investment [5], but proof of its longer-term sustainability will depend on the local water management committee and its ability to deal with current and possible future challenges to the balance of perceived fairness and efficiency. There are interesting parallels between the various scales of water harvesting involved: the *haveli* farmers want to shift the dams upstream to fully benefit from the fertile soil derived from past sedimentation, the Paranai-Sindh watershed now benefits from water harvesting in the haveli, but the downstream reservoir has lost some of its water harvesting subcatchments. From a fairness and rights perspective [6], it may help to establish a historical baseline relative to which change is quantified. A natural vegetation reference, rather than the degraded situation derived from this, seems to be appropriate, but will need further discussions in local context. More explicit documentation of local knowledge systems may help to establish such a baseline [7].

The watershed also provides an interesting opportunity to see how the Indian national agroforestry policy [8, 9] works out in practice. In a neighbouring subcatchment with higher forest cover, the base-flow fraction of river flow is reportedly higher but the total water yield per unit rainfall probably less [10]. The agroforestry policy could serve as a basis to assign water use rights to trees in the restored subcatchment.

Figure 34.4 The groundwater restoration has increased opportunities to keep buffalo's in the landscape and sell their products in the nearby town of Jhansi. Photo: World Agroforestry/Meine van Noordwijk

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