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Beyond water-intensive agriculture: Expansion of *Prosopis juliflora* and its growing economic use in Tamil Nadu, India

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ABSTRACT

Against the backdrop of expanding commercial crop markets and private well expansion, market-oriented agriculture has developed in villages with access to abundant water resources in Tamil Nadu, India. On the other hands, the villages that have failed to secure sufficient irrigation water have experienced sharp decline in cropping. Such land has been rapidly invaded by *Prosopis juliflora*, a tree species that has wide adaptability of the different environments and high coppicing ability. This species has traditionally been harvested as a fuel for domestic use and small-scale businesses, and recognised as "a tree for the poor". However, since the establishment of the electricity act in 2003, which completely deregulated participation of private companies in the electricity generation industry, the new usage of *Prosopis* has been created: several small-scale electricity generating plants began to utilise this tree as an energy source. As a result, the demand for *Prosopis* tree rapidly increased and the real price of raw wood has more than doubled between 2003 and 2009. A census survey of household income revealed that income generated from *Prosopis* expansion compensated for the decrease of cropping, and contributed to an increase in the net household income, especially for the landless labourers and middle class land holders. This fact indicates that it is possible to reduce poverty in a semi-arid rural area without securing additional irrigation water, in case proper institutions and technologies are in place.

Introduction

The extension of irrigation facilities has been a central feature of India's agricultural development strategy since independence (Vaidyanathan, 2006). In particular, well irrigation has played a critical role (e.g. Esho, 2008; Sivasubramaniyan, 2006) in increasing yield per unit of land for traditional crops, such as rice and wheat (through the 'Green Revolution'). As a result, India started to export rice at the end of the 1970s (FAO, 2013). This increase in agricultural production has supported to the recent rapid growth of the Indian economy, which has maintained a growth rate of approximately 6% per annum since the beginning of the 1980s (Yanagisawa, 2008).

Such an ideal combination of irrigation, agricultural growth, and reduction in poverty is unlikely to be available during the next phase, when agricultural growth must increasingly come from less favourable regions where water is a limiting factor (Shah, 2001). Water shortages threaten the livelihoods of farmers and agricultural wage labourers in various parts of India. Seasonal movement of the labour force from water-scarce regions to irrigated and/or economically developed regions has been a common survival strategy, but long-term or permanent out-migration has also been increasing (e.g. Shah, 2009; Sundari, 2005; Venot et al., 2010). This situation is also true in the Gundar River basin, located in the southern part of Madurai, Tamil Nadu, India. Rapid expansion of private well irrigation in this area has enabled farmers in the upper watershed to introduce cash crops with high water requirements; however, farmers in the lower watershed face unfavourable water conditions and have failed to introduce cash crops (Sato and Periyar Ramasamy, 2011). A large amount of arable land has been abandoned in the lower watershed because only less profitable crops can be grown in this area. Such changes in land use have allowed the widespread invasion of tree species, such as *Prosopis juliflora* (Swartz) D.C. (Sato and Periyar Ramasamy, 2011).

The British Colonial Government introduced *Prosopis* into India in 1877 (Perera et al., 2005). It has spread into many parts of India since the 1960s (Saxena, 1993), although the reason for the boom of *Prosopis* is unclear (e.g. Saxena (1993) described it as 'spontaneous'). Because of its tolerance to drought, submergence, and salinity, and its high coppicing ability (Elfadl and Luukkanen, 2003; Mahmood et al., 2001; Shiferaw et al., 2004), *Prosopis* has been widely used as a fuel wood or charcoal resource in India's semi-arid zone (Perera et al., 2005; Saxena, 1997) and has been recognised as an important income source for poor inhabitants

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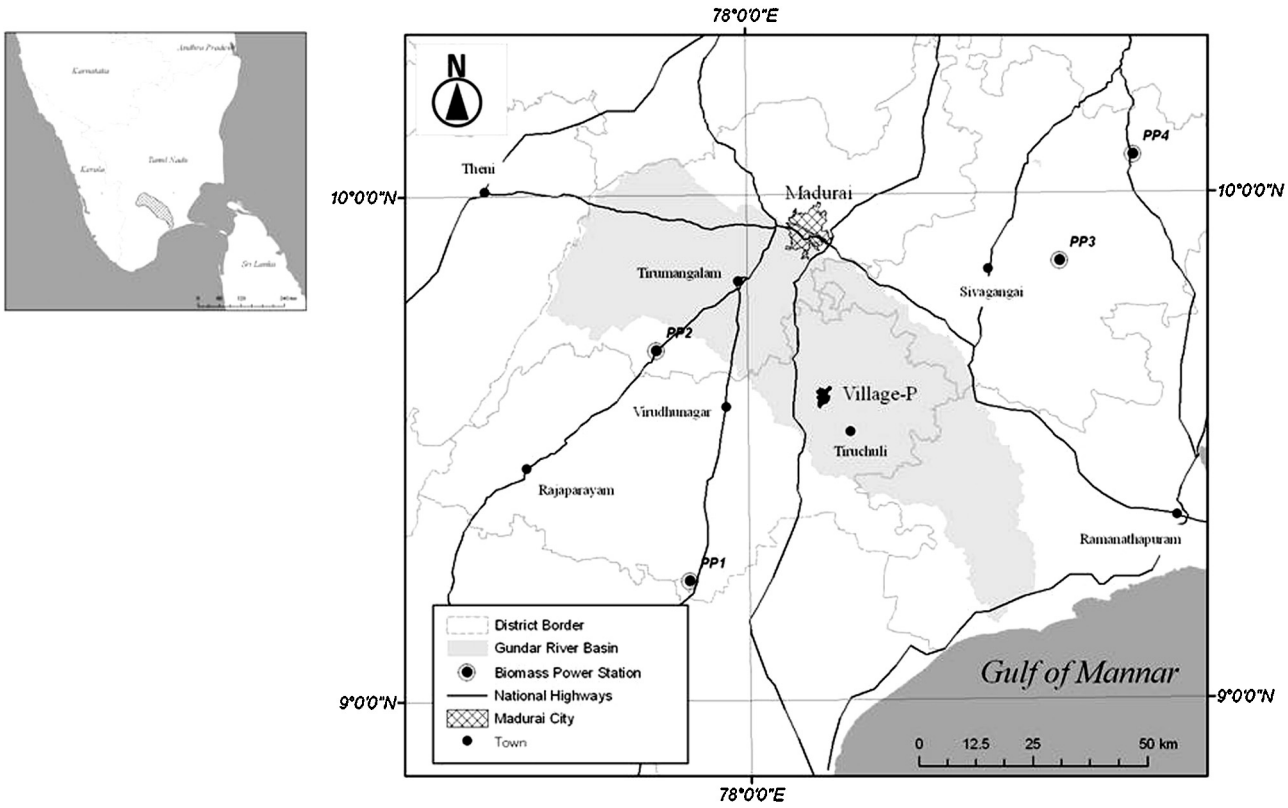

Fig. 1. Map of the study area.

Data source: Author's field survey (2011).

(Jambulingam and Fernandes, 1986; Perera et al., 2005; Saxena, 1993). Saxena (1993) reported that the total yield of *Prosopis* for firewood accounted for 75% of all fuel consumed in Tamil Nadu. However, all of India, including Tamil Nadu, is now in a state of energy transition (Singh et al., 2012; Van Ruijven et al., 2011), and traditional energy resources such as *Prosopis* are rapidly being replaced by modern energy sources, such as kerosene or propane gas. This energy transition is expected to affect poor inhabitants of rural regions, who have been securing their incomes through *Prosopis*-related activities. Some scholars have examined the economic value of *Prosopis* (e.g. Haji and Mohammed, 2013; Mwangi and Swallow, 2008; Saxena, 1997), but no study has examined this species in relation to energy transition.

This study examined the effect of *Prosopis* tree expansion on rural livelihoods in a semi-arid area, the southern part of Tamil Nadu, India, based on recent field surveys and our previous study (Sato and Periyar Ramasamy, 2011). First, the process of *Prosopis* expansion in a selected village is described. The energy transition in India and its influence on *Prosopis* demand are then examined. Next, the effects of the increasing demand for *Prosopis* on household income are presented, followed by a discussion of the major issues raised by this study and the implications of our results.

Materials and methods

The study village

There are 17 major river basins in Tamil Nadu, one of which is the Gundar River basin. The study village,[1] Perunjaripudupatti Village (Village P), is located in the middle of the basin and belongs to Virudhunagar District (Fig. 1). Village P is located about 30 km south of Madurai, the second largest city in Tamil Nadu. However, access to Madurai is limited because the journey to the city from the village takes more than 2 h. The landholding status of Village P residents is presented in Table 1. In 2011, the village had a total population of 878 individuals in 234 households. Government census data listed 302 households in Village P in 1991 and 273 in 2001 (Government of India (GOI), 1991; GOI 2001), indicating a decrease in the number of households in Village P since the 1990s. In 2011, landless households comprised 44.4% of all households. Marginal households owning < 1 ha made up 31.2% of all households and were occupied by more than half of all landholders.

Fig. 2 shows a map of the study village, which has a total geographical area of 767 ha. Two tributaries of the Gundar River (the Thekkar and Goundanathi rivers) meet at this village, although they are both seasonal.[2] An irrigation tank, which is used to irrigate the *nanjai* ('irrigated land' in Tamil), is located in the northern part of the village. The *punjai* ('dry land' in Tamil) extends widely on the southern sides of the rivers. In terms of the land tenure system, this village land can be separated into four categories: an irrigation tank (including a bund), *nanjai*, *punjai*, and residential areas. The village owns the irrigation tank. Crop cultivation within this area is not allowed, but any villager can collect plants growing there (including *Prosopis* for firewood) for his or her own use. The water stored in this tank is used to irrigate *nanjai*. According to older residents,

[1] In our previous study, we conducted a sample survey of villages (including Village P) that identified unequal irrigation water distribution within the target river basin (Sato and Periyar Ramasamy, 2011), This village was selected again for this study because of the established relationships with villagers and because the land cover in this village represented the forefront of *Prosopis* expansion, which suited the analysis.

[2] According to interviews with villagers, no river flow has occurred since 1998.