



# The impacts of shrimp farming on land-use and carbon storage around Puttalam lagoon, Sri Lanka



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## ABSTRACT

The expansion of shrimp aquaculture in Sri Lanka over the past three decades has dramatically changed the coastal landscape, in particular by converting mangrove forests. The current study quantified these impacts in the Puttalam lagoon, an area of the country that has experienced some of the most destructive development. Land use change was analysed using a multi-temporal set of aerial and satellite images taken in 1992/1994 (aerial photographs), 2007 (SPOT 5) and 2012 (Pleiades). The area of shrimp farms increased by 2777% over this 19-year period, with salt pans expanding by 60%. Mangroves declined in area by 34% and coconut groves increased by 17%. Because of problems with disease many intensive shrimp farms are abandoned after a few years, leaving denuded and unproductive landscapes; here a large majority of farms (90% of the total area of shrimp aquaculture) were found to be abandoned. The loss of carbon sequestration and storage services caused by this unsustainable recent history of shrimp farming was calculated as one measure of environmental impact. The documented land use changes in Puttalam lagoon resulted in an estimated net carbon loss of 191 584 tC. This was mainly due to conversion of mangroves to shrimp farms, making up 75.5% of the total carbon loss. These results demonstrate the scale of environmental degradation caused by intensive shrimp farming in the study area, and highlight the need for an entirely new aquaculture model in Sri Lanka.

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## 1. Introduction

Although shrimp production in coastal pond systems is a traditional practice in Asia (Dierberg and Kiattisimkul, 1996; Bergquist, 2007), recent decades have seen a huge increase in the extent and intensity of shrimp aquaculture activities, driven by consumer demand from Japan, North America and Europe (Primavera, 1997; Thornton et al., 2003; Bergquist, 2007; Bosma and Verdegem, 2011). Sri Lankan shrimp farming became one of the fastest growing industries in the 1980s, most likely inspired by the profits seen in established shrimp farming practices in

countries such as Thailand, Ecuador, Indonesia, China and Vietnam (Cattermoul and Devendra, 2002; Munasinghe et al., 2010).

Sri Lanka has 1700 km of coastline comprising lagoons and sheltered bays that are prime sites for aquaculture development (Dayananda, 2004; Drengstig, 2013). Shrimp farming started in the north western coast of the country, with pioneer farms established around Chilaw Lake (Fig. 1; Senarath and Visvanathan, 2001), which were followed by rapid expansion particularly concentrated along the coast from Chilaw to Puttalam lagoon in the north western province (NWP) (Dahdouh-Guebas et al., 2001; Munasinghe et al., 2010).

The major shrimp species cultured in Sri Lanka is *Panaeus monodon* (Fabricius), commonly known as black tiger shrimp, which is naturally found along the Sri Lankan coast (Cattermoul and Devendra, 2002). During its peak period, shrimp farming was an important source of employment in Sri Lanka and shrimp exports represented one of the main sources of foreign exchange for the country, accounting for 40–50% of total aquaculture exports

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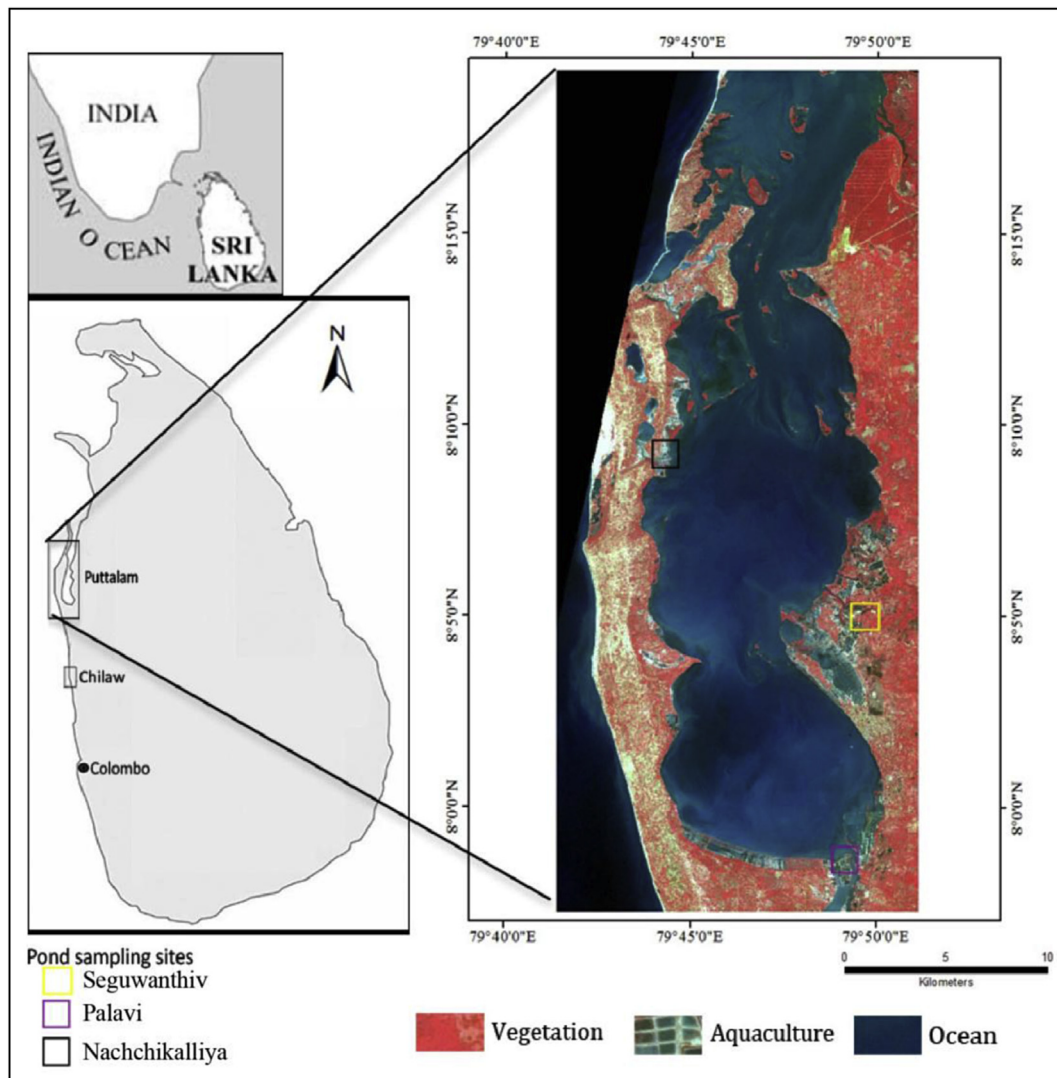


Fig. 1. Overview of the study area: Puttalam lagoon in the north western province in Sri Lanka (SPOT 5 data acquired in 2007, RGB = NIR-red-green).

(Senarath and Visvanathan, 2001; Dayananda, 2004; Munasinghe et al., 2010). Although there is significant potential for the industry to contribute to national economic growth and to reduce poverty, unsustainable shrimp culture causes environmental as well as socio-economic harm due to the exploitation of coastal natural resources (Bergquist, 2007; Rajitha et al., 2007). The major environmental impacts of unsustainable shrimp farming have been well documented. The main problems are caused by direct conversion of natural habitats to shrimp ponds, which leads to drastic loss of mangrove forests, salt marshes, seagrass beds and mudflats, along with many of their associated ecosystem services (Senarath and Visvanathan, 2001). Other environmental impacts are caused by the disposal of untreated wastewater, rich in nutrients and often laden with pesticides and antibiotics, directly into lagoon waters (EJF, 2004; Primavera, 2006). Furthermore, excessive use of antibiotics encourages the emergence of antibiotic-resistant strains whilst chemical discharges damage off-target populations and pollute aquifers (Primavera, 2006; Bosma and Verdegem, 2011). Other environmental impacts may include declines in wild capture of fish and shrimp (Cattermoul and Devendra, 2002) and the spread of diseases such as the White Spot Syndrome Virus (WSSV), which is considered the most serious pathogen of shrimp, causing 100% mortality within 7–10 days in infected shrimp farms (Witteveldt

et al., 2004; Primavera, 2006). In the NWP of Sri Lanka, which includes Puttalam lagoon, the Dutch Canal is the main source of water for shrimp farms. This semi-enclosed coastal water system has a low flushing rate, which exacerbates these problems, with hydrological changes, salinization of soil and water and siltation now also recorded in the area (EJF, 2004; Weerakoon, 2007).

Because of disease and other problems, the productivity of intensive shrimp ponds often declines after 4–10 years. Ponds may then be abandoned and new areas cleared during the establishment of new ponds (Bosma and Verdegem, 2011). There are socio-economic as well as environmental costs of intensive shrimp cultivation. The poorest people on the coast are usually highly dependent on coastal ecosystems such as mangroves (Dayananda, 2004). In Thailand, it has been estimated that intact mangrove forests have a total economic value 70% higher than shrimp farms, largely because of the range of ecosystem services that are destroyed by conversion of mangroves to ponds (Primavera, 2006). The expansion of aquaculture despite these economic losses is testament to differences in power between those who benefit and lose rather than any economic logic. A pattern of rapid expansion followed by abandonment and local collapse of the industry, with resultant coastal unemployment, is a sadly familiar story (Primavera, 2006).

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