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Assessing the ecosystem services value of Can Gio Mangrove Biosphere Reserve: Combining earth-observation- and household-survey-based analyses

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A B S T R A C T

In this paper we present the results of an ecosystem service value derivation for the Can Gio Mangrove Biosphere Reserve in Vietnam. We combine earth-observation-based mapping at the main species level with the result of an extensive socio-economic household survey to assess the value of direct and indirect ecosystem services provided by Can Gio's mangroves. Remotely sensed optical and radar data from 2011 were used to derive the precise extent of mangrove coverage. Household survey results led to an understanding of the value placed on mangroves by different occupational groups, namely, forest managers, fisherman, shrimp farmers, and other farmers. Common to all is a lack of understanding of the value of a natural resource if no direct income is generated. At the same time, depending on occupation, a clear trend towards appreciating and understanding the importance of mangroves can be observed: it is the highest with local and migratory fisherman, followed by forest managers, while shrimp farmers have the least knowledge about mangrove benefits, and also express the least willingness to further protect them. Values derived from the household surveys as well as secondary sources – in combination with remote-sensing-based mapping – enabled us to determine the ecosystem services value of Can Gio mangroves for selected categories of advantages.

Introduction

Ecosystem services

According to the Millennium Ecosystem Assessment (Carpenter, 2005), ecosystem services are "defined as the benefits people obtain from ecosystems. These include provisioning services such as food and water, regulating services such as the regulation of floods, drought, land degradation, and disease; supporting services such as soil formation, and nutrient cycling; and cultural services, such as recreation, spiritual, religious, and other non-material benefits".

Ecosystem Services value can be differentiated into direct use values, DUV (direct benefits provided by the ecosystem, (for mangroves, e.g., the provision of timber, honey, medicine, chemicals); indirect ecosystem use values, IUV (for mangroves, for example, the value of carbon sequestration, water cleansing capacity, shoreline protection, or tourism); and existence values (cultural or spiritual values favouring the existence of rare species, etc.). The total economic value, TEV, of an ecosystem is usually the sum of DUVs plus IUVs, as well as so-called existence values, EV, (values independent of current or future use, such as the value of a species existing instead of becoming extinct, which can be measured, for example, by the extent of donations to conservation organizations, etc.). Many of these values can be derived from a combination of market prices. However, there are also other ways to value direct, indirect or existence economic services, as enlisted in detail in Costanza et al. (2006). These include, for example, Avoided Cost Values, which are services allowing society to avoid costs, (e.g., flood control measures, which would have to be initiated if the mangroves were not there), and Travel Cost values, TC (if recreation areas with mangroves attract distant visitors), amongst others. A detailed review of valuation methods for the ecosystem services provided by mangroves can be found in Vo Quoc, Kuenzer, Vo Quang, Moder, and Oppelt (2012)

To spatially map the ecosystem services values of biogeographic entities according to Troy and Wilson (2006), at least six steps are mandatory. In this study we follow these steps, which are the following:

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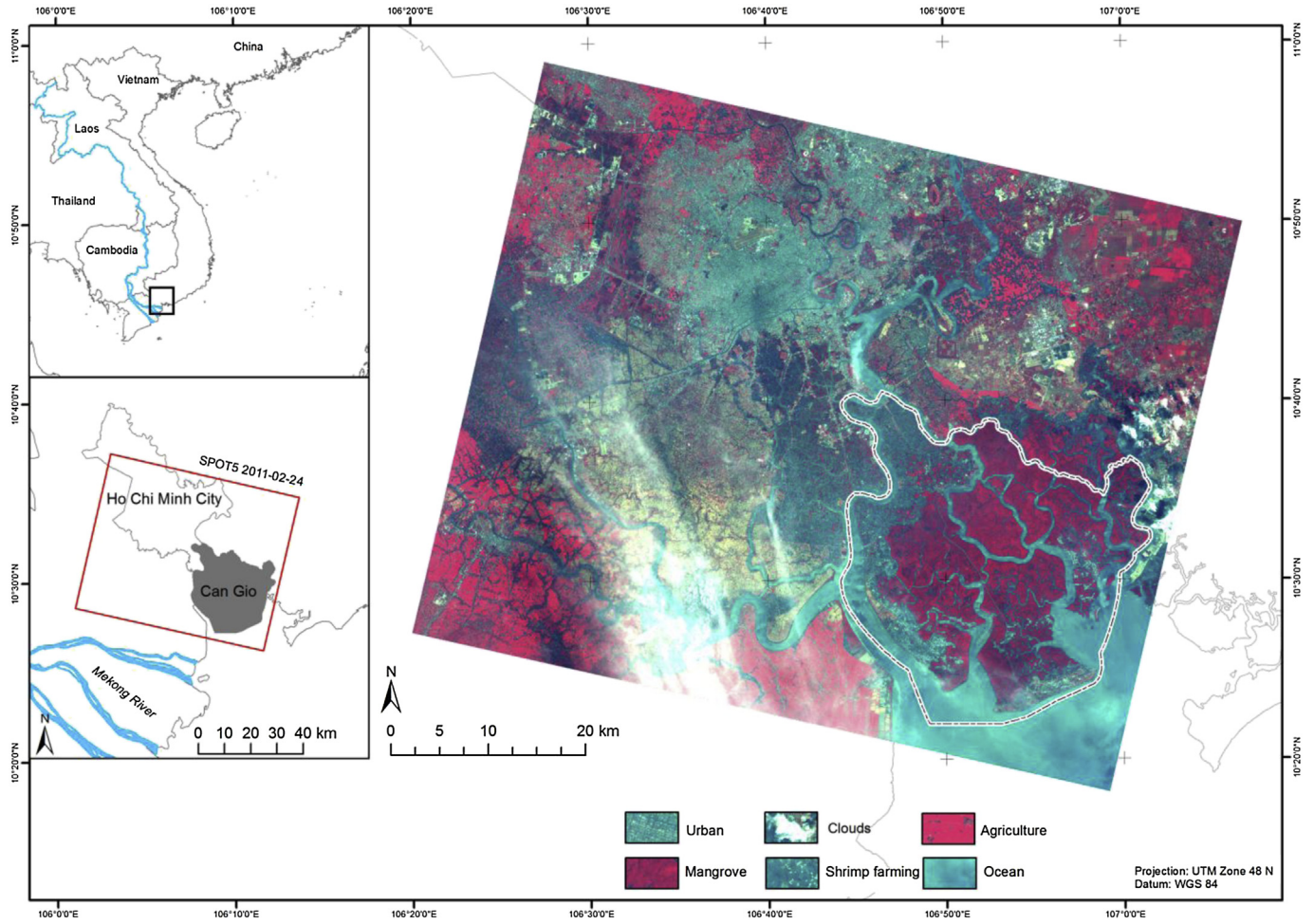

Fig. 1. Location of Can Gio district within Ho Chi Minh City province, as seen in recent (February 2011) false-colour SPOT satellite imagery. Dark red areas within Can Gio district represent vegetated (mangrove) areas. Ho Chi Minh City, HCMC, with currently over seven million inhabitants – a rapidly growing urbanization – is located directly to the North. Furthermore, it can be seen that major waterway connections from the coast to HCMC (and its harbour) lead directly alongside or even directly through the Biosphere Reserve. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

1) Study area definition and description
2) Typology development, e.g., development of a relevant legend or mapping scheme (e.g., for land use or species mapping based on earth observation data)
3) Literature search and analysis of comparable empirical studies, preferably for a similar context (to transfer ecosystem services values, either independently or as a complement to primary analyses)
4) Mapping (map creation based on geospatial data)
5) Total value calculation
6) Geographic summary (a combination of the results from 3 to 4 above).

Research goals

Next to fulfilling the above six points, the research questions we aim to answer in this paper are the following:

- Which ecosystem services exist in Can Gio Mangrove Biosphere Reserve and which current challenges and threats is Can Gio Mangrove Biosphere Reserve facing?
- Which occupational groups live in the reserve, and how does the valuation of mangroves differ depending on occupation and educational background?
- What are the direct and indirect values of selected ecosystem services?
- Which recommendations for action can be postulated?

The study area: Can Gio Mangrove Biosphere Reserve

Can Gio (CG) district is one of 18 suburban districts located approximately 50 km south of Ho Chi Minh City, HCMC, Vietnam. It covers an area of 71,964 ha (Hirose et al., 2004, 2011) and with 67,272 inhabitants (2011) has a low population density. The main economic activities of local people are forest management, agriculture, fishing, aquaculture, and salt production.

The climate of Can Gio is typical for tropical monsoonal zones with two distinct seasons. The annual average temperature is 25.8 °C, and rainfall and humidity vary between the dry and the rainy season. The dry season starts in November and lasts until the end of May; the rainy season lasts from the end of May until the end of October. Annual average precipitation in Can Gio ranges from 1300 to 1400 mm. Soil salinity ranges from 0.5% during the rainy season up to 2% in the dry season (UNESCO/MAB Project, 2000). As shown in Fig. 1, Can Gio is situated in an estuarine complex of tidal flats, where the Vam Co, Saigon, and Dong Nai rivers discharge into the South China Sea. The Long Tau River is the main coastal shipping waterway, allowing ships with up to 20,000 tons carrying capacity to enter HCMC port (Luong, 2011). The area experiences a very dynamic bi-diurnal tidal regime, ranging from 2 to 4 m tidal amplitude depending on the season (Truong, Pham, Le Kim, &