

ANALYSIS OF COASTAL TOURISM WITH THE AID OF REMOTE SENSING

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ABSTRACT

The coastal zone is the source of a number of resources that gives rise to distinctive activities, especially tourism. Sun, sea and sand provide the necessary ingredients for coastal tourism. Coastal tourism is environmentally dependant and it unavoidably imposes negative impacts on the coastal environment which supports its existence. Remote sensing as a relative new technique has been applied in many coastal zone studies but far from enough for coastal tourism. It has been proven to be both an effective and economical technique. This research aims at developing an approach to utilize and apply information and data from remote sensing in support of other information sources to better manage coastal tourism. The study area is Ameland, one of the Wadden Sea islands of the Netherlands. Aerial photography, as one of the oldest methods of remote sensing, is still very important in the interpretation of coastal tourism products. (Jingnan, 2000).

1. INTRODUCTION

1.1. Coastal Zone

The coastal zone is the interface where the land meets the ocean, encompassing shoreline environments as well as adjacent coastal water. Its components can include river deltas, coastal plains, wetlands, beaches and dunes, reefs, mangrove forests, lagoons and other coastal features. (Post and Lundin, 1996). The coastal zone occupies less than 15% of the Earth's land surface. Only 40% of the one million km of coastline is accessible and temperate enough to be habitable. Yet it accommodates more than 60% of the world's population. (FAO, 1998).

1.2. Coastal Tourism

The coastal zone contains a number of resources that give rise to distinctive activities, including tourism. Tourism is the world's largest growth industry with no signs of slowing down in the 21st century. Although there are no standardized practices for reporting tourism statistics within the coastal zone, it is not difficult to see how tourism has a major coastal aspect. The inherent character of the coastal area makes its tourism distinctive. Historically, the use of coastal zone for tourism dated to Roman times when holiday villas were available on the northern side of the Bay of Naples. (Wong, 1993). Although as a 'smokeless industry', there is no escaping of the fact that a booming coastal tourism with the construction of hotels, airports and marinas, and the operation of tourist facilities fundamentally alter the coastal environment and displace communities. (Miller and Auyong, 1991).

1.3. Coastal Tourism Product

Coastal tourism product include coastal tourism resources and the related tourism facilities. (Zee, 1992). As for this study, coastal tourism resources is divided into natural resources and historical resource. Not all resources can become tourism resources unless certain conditions are fulfilled: physical suitability, scenic quality and accessibility. (Zee, 1992). The resources, along with tourist activities, determine the coastal tourism facilities.

Coastal Tourism Product { Tourism Resources (Biophysical and socio-economic aspects, scenery, etc.)
Tourism Facilities (primary facilities, secondary facilities)

'Primary facilities' here mainly refers to the stay accommodation and access facilities. Secondary facilities could be further subdivided into sport facilities, facilities for informal pursuits and entertainment facilities. (Zee, 1992). Some facilities have mixed functions such as swimming pool, which can be plain swimming lanes or added with other entertainment facilities.

1.4. Remote Sensing Used in the Study of Coastal Tourism

In the study of coastal tourism management and decision making for better conservation of the coastal ecosystem, a management system has been designed: Integrated Coastal Zone Management (ICZM). Integrated use of field surveys, remote sensing and Geographic information systems (GIS) have been proven to be useful. In such a system, optimum use should be made of remote sensing since it has been shown to be cost-effective. The use of

periodic remote sensing applications can track and monitor the cumulative impact of land use changes. (Hobma, 1999).

To sum up, using remote sensing in the study of coastal tourism has the following advantages (Zee, 1992):

- Effectiveness : In a short time with little manpower a large amount of data can be obtained;
- Economic: By saving manpower, remote sensing could also help saving budget;
- Advantage over human eyes: By certain types of sensors specific characteristics of objects, that are not visible to the human eye or not even reachable by human being, can be registered into images;
- More suitable for interpretation: It provides the observer with a permanent representation of objects, phenomena and relationships as they exist at a given time. The permanence and fidelity of remote sensor images permit the interpreter to intensively study an area in a more leisurely fashion and in circumstances more favourable than during direct observation; and
- A database for future usage: Analysis of remote sensing data can provide an important input to GIS. The same data can be analyzed again and again for various objectives and purposes.

2. AMELAND

The case study area is Ameland, one of the Wadden Sea islands of the Netherlands.

2.1. Tourism Resources of Ameland

Ameland has four villages: Hollum, Ballum, Nes and Buren (Figure 1).



Figure 1: General map of Ameland (EcoMare, 2000).

• Cultural Resources for Tourism

The island is rich in its history. Between 1430 and 1681, the Frisian Cammingha family ruled and exercised great influence on the life of the islanders. The infamous keep in Ballum was the stronghold from which they 'governed their domain.' Whaling industry prospered in the 18 century. Around 1770, Ameland counted more than 128 skippers and commanders of whaling boats, who brought home great prosperity. (VVV Ameland, 2000). The main cultural resources of Ameland are:

Lighthouse: The lighthouse is a symbol of Ameland. It is still working and opened to the public on certain times.

Windmills: Windmills are unique attractions in the Netherlands. There are 2 windmills in Ameland.

Museums: The rich history has been exhibited by several interesting museums which are inside villages.

• Natural Resources for Tourism

Accessibility as one of the certain conditions determines the usage of natural resources. Unlike cultural resources, natural resources are not tourism resources in cases when they are not allowed to be (such as the natural reserve area of Ameland).

Sun, Sand and Sea: Ameland has a higher count of sun hours with less rainfall compared with the mainland. The North Sea and the beaches, the Wadden Sea and the tidal flat are all very important tourism resources. The coastal water caters popular aquatic sport areas. Tidal walking in the area is an activity with a long tradition. The North Sea also creates beaches and the sand hook. Ameland boasts no less than 27 kilometers of white beach (four bathing beaches), which is the island's main attraction.

Forests and dunes: Dunes are mainly inside the beaches of the North Sea while forests can be found in patches over the island. There are ninety kilometres of bicycle tracks meandering the dune areas and forests. walking, bicycling or even horse riding are very favourite activities of the tourists.

Fauna and flora: A diversity of bio-types naturally results in rich fauna and flora, which in turn is a source of visual delight for bird watching, tidal fishing and many other activities of tourists. (VVV Ameland, 2000).

• Secondary Facilities as Tourism Resources

Two facilities, the airport in Ballum which supports air tour and sport skydive and the professional golf courses in Hollum could be regarded as tourism resources. They attract tourists from outside the island as unique sport facilities of the island. At the same time, they can be served as tourism facilities. (Zee, 1992).

2.2. Tourism Facilities

2.2.1. Primary Facilities

- **Stay Accommodation**

The accommodation types on the island could be classified into six groups: hotels, group houses, apartments, bungalows, caravans and camping terrains (the tents are carried by tourists themselves, camping is only allowed in certain places). The Gemeente (administration organization) of Ameland rules that the accommodations for tourists should be outside villages.

- **Accessibility Facilities**

Ferry harbour: There are two dams represent the infrastructure that links the island with the outside world. The larger dam extending to the deep water serves as the ferry harbour.

Roads: Five types of roads are differentiated according to the topographic map: Main roads, local roads, unmetalled roads, bicycle track and footpath. (Zee, 1992).

2.2.2. Secondary Facilities

- **Sport Facilities**

Airport in Ballum: The airport is now used for skydiving and air tours in tourist high seasons.

Golf courses: A vast area of golf course in Hollum near the caravan and bungalow.

Swimming pools: Two big sized indoor swimming pools nearby the lake of Nes.

- **Facilities for Informal Pursuits**

Bicycle tracks: The bicycle tracks paved with shells inside the dune area along the dike of the North Sea.

Wandering paths: Narrower paths narrower than the bicycle tracks, mainly in the forests and the dune areas.

Yachting harbour: The small dam is served as yachting harbour only reachable at high tide. Many yachting boats can be moored here in tourist high season. There are also big local boats for sailing tours.

- **Entertainment Facilities**

Playgrounds: Three outdoor playgrounds scattered in the island.

Swimming pools with waterslides: Belong to the camping site of Ballum

Other entertainment facilities: Cinemas, theatres, fair grounds, amusement halls, bars, night-clubs, etc.

2.3. Material Collection

- **Pre-field Work**

Before going to the field, materials of the study area were collected. See table 3.4 of the available useful material. Some digital image processing has been done in ILWIS, the GIS software.

Type of Data	Date	Number	Note
Topographic map	1979/1980	1 sheet	Scale 1:25000
Tourist map	1996	1 sheet	Scale 1:25000
Panchromatic airphotos	03-06-1969	11	Scale 1:18000
Panchromatic airphotos	04-05-1992	11	Scale 1:18000
	25-04-1992	11	
Panchromatic airphotos	13-05-2000	24	Scale 1:18000
SPOT Pan, in ILWIS	28-06-1986	1	Unknown
SPOT XS, in ILWIS	28-06-1989	3	Band 1-3
LandSat TM, in ILWIS	15-05-1992	7	Band 1-7

Table 1: Available useful materials for the study.

- **Field Work**

The field trip had helped in getting an integral impression of tourism of the island. The villages, all kinds of accommodations and other useful knowledge later aided in the interpretation of the airphotos. The visit to the Gemeente of Ameland also helps in the understanding of its policy making for tourism and recreation.

3. USING AERIAL PHOTOGRAPHS FOR INTERPRETATION OF TOURISM PRODUCT

In the field of recreation studies, a lot is still done with aerial photographs (Zee, 1992). Aerial photographs have better spatial resolutions than most satellite images (expect IKONOS). They can be used to make inventories of tourism resources and facilities. Especially when taken under suitable weather conditions in tourism high seasons, aerial photographs can also be used to interpret tourism activities. By comparing series of airphotos of different time during different periods, changes in recreation and tourism can also be traced.

3.1. Interpretation of Tourism Resources

- **Interpretation of Cultural Tourism Resources**

Except these listed below, other objects functioning as cultural resource of tourism had not been interpreted due to the small scale of the airphotos. Many old museums in the villages could not be interpreted because of their similar outlook to other normal buildings on the airphotos.

Lighthouse: The interpretation of lighthouse is easy with the help of stereoscopes while it seems extruding above the airphotos. But it is impossible to be interpreted without the stereoscopes.

Windmills: When taken in sunny days, the shadows of the windmills can help the recognition. On vertical airphotos with the relatively small scale 1:18000, if without sunshine, it might be impossible to interpret them.

- **Interpretation of Natural Tourism Resources**

These resources are possible to be interpreted. However, it is always difficult to identify their usage by tourism.

Sea, sand and sea: Some beaches used for tourism can be identified easily when the airphotos are taken in good weather in tourist high seasons because recreational and tourist activities increase in such conditions. See the beach on figure 2, the little black dots are windscreens on the beach.



Figure 2: The beach in the north of Nes in 1969.

When weather is unsuitable for people to go to the beaches, the secondary facilities on the beach can still give some clues, for example kiosks, restaurants and roads leading to the beaches.

forests and dunes: Some paths (especially when they are meandering, impossible for the use of forestry) in the forests might indicate those parts of forests are for tourism and recreation usage. The bicycle tracks can help in interpreting where in the dune areas and tidal marsh areas tourists are allowed and accessible.

fauna and flora: Fauna and flora for the usage of tourism are difficult to be interpreted. Cows, horses and sheep are in the fields on the airphotos, but they are not unique tourism resources. Birds had not been found on these airphotos, and the possibility of that is low.

3.2. Interpretation of Tourism Facilities

3.2.1. Interpretation of Primary Facilities

- **Stay Accommodation**

Hotels: For hotels inside villages, it is rather difficult to identify them on the airphotos of the scale 1:18000. Inside villages the assumption that all large buildings have a recreational function is less valid, because a number of other functions can be expected to have large buildings too: school, church, supermarket and museum, etc. Large building outside the agricultural area and villages that is too large to be individual summer houses can be assumed to serve recreational purposes, simply because that is the only likely function to be expected here on basis of local reference knowledge. A further specification can not be given without field information. (Zee, 1992). Hotel Ameland which has a round car park with grassland in two half circles is easily identified on the airphoto (figure 3).



Figure 3: Hotel Ameland seen from ground (VVV Ameland, 2000) and on the airphoto.

Apartment buildings: It is relatively easier to recognize the apartment buildings on the airphotos because their locations (outside villages, near the beach and camping sites), big buildings in groups and the car parks (figure 4).



Figure 4: The Ostrea Apartment Complex seen from ground (VVV, Ameland, 2000) and on the airphoto.

Bungalows: Bungalows (this group refers to those bungalows aggregates in the bungalow sites) are easy to be interpreted because of their conspicuous shapes. On the airphoto, they are bigger than the caravans, darker in tone and smaller the service buildings. A good example for interpretation of bungalows is the Klein Vaarwater. The bungalows range from free standing bungalows to shackle bungalows (figure5).

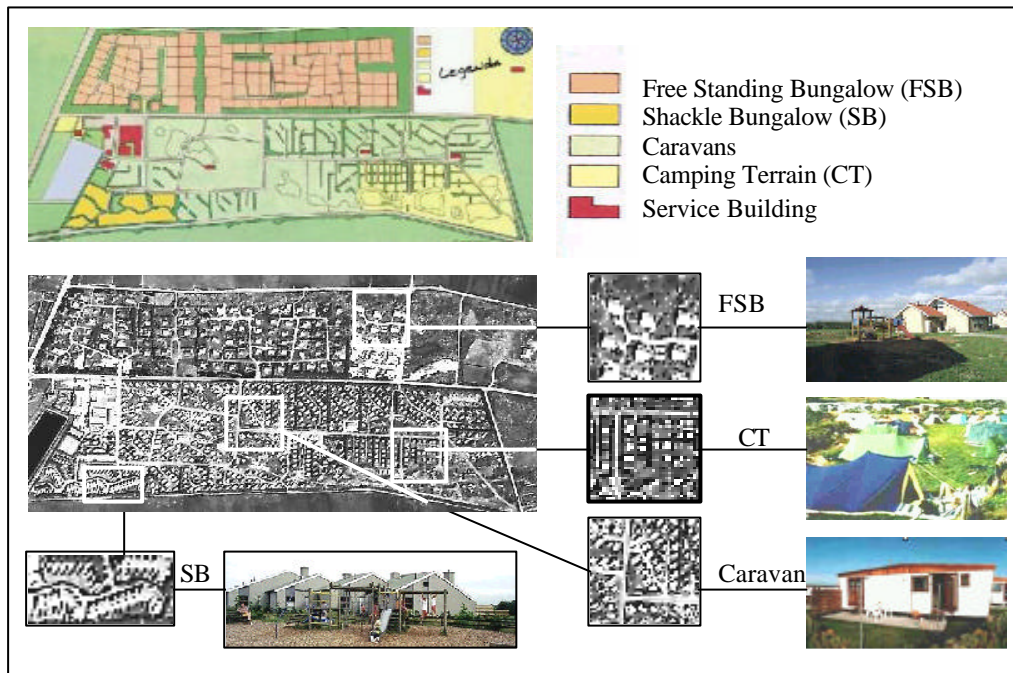


Figure 5: The arrangement map and airphoto of Klein Vaarwater with some detailed photos (VVV Ameland, 2000).

Caravans: Caravans are easy to be detected because of their well-known pattern of small light-toned objects. They are smaller than bungalows and have a flat top if studied under stereoscopes (figure 5).

Tents: Their tops are steeper than that of caravans under the stereoscopes. Tents are usually limited inside the small hedge-in fields and associated with a few larger and darker toned buildings representing the sanitary and other common facilities (figure 5).

- **Accessibility Facilities**

Ferry harbour: The large dam and the ferry harbour is clearly visible with bare eyes on the airphoto (figure 6).

Road: Main roads (broader roads with roundabouts) and local roads can be differentiated (figure 6).

3.2.2. Interpretation of Secondary Facilities

- **Sport Facilities:**

Air strip: The airport of Ballum can be identified on the airphoto by its elongated shape.

Golf Courses: The interpretation of the golf courses needs basic knowledge. On the stereo pair of the airphotos, neatly short-cut greens associated with the bright white spots of the sand bunkers, areas with rough grassy vegetation as well as small (dark toned) ponds, trees and shrub could all be hints (Zee, 1992).

Swimming pools: Beside the lake of Nes, two domes were interpreted as swimming pools. The interpretation was easy due to their special roofs (figure 7).

Indoor gyms: On the airphotos they are impossible to be identified.

- **Facilities for Informal Pursuits**

Bicycle and wondering tracks: They are meandering along the dikes to the North Sea side of the island and are quite bright (paved by shells) in contrast to the dark grey vegetation in the nearby dune areas and can be observed on the airphotos with bare eyes.

Yachting harbour: Between the two dams, some boats can be found on the airphotos. These boats are mainly used for recreation. The big boats on figure 6 which are also used for seal-tours. The smaller boats are privately-owned yachting boats.



Figure 6: The recreational boats in the yachting harbour.

- **Entertainment Facilities**

Playgrounds: A playground at the western end of the island inside the dune can be interpreted by its regular rectangular shape. It must not be car park because no main roads or local roads can reach it.

Swimming pool: On the airphoto of the camping site in Ballum, one outdoor swimming pool was found under stereoscopes. The deeper-water part on the left is surrounded by a higher rim, the shallower-water part is larger and a circular waterslide is at the right side.

3.3. Using Aerial Photographs for Detection of Changes of Tourism Products

By studying series of aerial photographs of year 1969, 1992 and 2000, the changes in tourism product of Ameland can be detected. Here is an example (figure 7):



Figure7: The lake area in Village Nes on photos: 1969 (left), 1992 (middle) and 2000 (right).

The lake in 1969 was small and oval. It had been expanded as observed from the airphotos of 1992 and 2000. Also easily detected are the two domes at the west bank of the lake being indoor swimming pools on airphotos of 1992 and 2000. To the west of the swimming pool (indicated with white circles) more buildings had been added in 1992 and 2000. Two elongated buildings in the circle of photo 2000 are a Natural Museum and an apartment building.

4. USING SATELLITE IMAGES FOR INTERPRETATION OF TOURISM PRODUCTS

The spatial resolution of the available satellite images is too low and they had been proven of limited usage in the interpretation of tourism products of Ameland. Possible applications of satellite images have to resort to the help of relative knowledge e.g. topographic maps or field visits.

5. CONCLUSION

Due to their high spatial resolution, aerial photographs are highly recommended for the study of coastal tourism. Original photographs are most preferred because of their richest information. The stereo view and enlargement facility of the mirror stereoscopes give clearer impression than the airphotos in mono-scopic vision (Zee, 1992). Scanned photos have the advantage of enabling zooming in the interested areas. They can be imported into GIS softwares and then be used for other analysis such as mapping of tourism products.

Low spatial resolution is the biggest hinderness of satellite images for the application in coastal tourism. Satellite images can be effective and economically useful in assessing and monitoring changes of coastal tourism on the basis of former information (Jingnan, 2000).

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