Utilization of ASTER Data for Wetland Mapping of Kushiro Mire and Iriomote Island, Japan

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ABSTRACT

ERSDAC is doing research and development in ASTER data use technology to apply the resources exploration, environmental monitoring and disaster management with a global scale besides ASTER mission operation, data processing, and distribution. The objective of this study is to develop methodology for wetland mapping using ASTER data, and we hereby introduce, for example, wetland map of Kushiro Mire and Iriomote Island in Japan made by applying the method to ASTER data. The accuracy of the extraction was both certified approximately 90% by truth data. So this method is not only to be useful for monitoring wetlands but also to contribute to " wise use" as the Ramsar concept.

1. INTRODUCTION

Under the text of the Ramsar Convention, wetlands are defined as "area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exeed six meters". In addition, there are human-made wetlands such as fish and shrimp ponds, farm ponds, irrigated agricultural lands, salt pans, resorvoirs, gravel pits, sewage farms, and canals. Wetlands occur in every country, from the tundra to the tropics.

How much of the earth's surface is presently composed of wetlands is not known exactly, however according to an estimate of the World Conservation Monitoring Centre, about 570 million hectares (5.7 million km2), roughly 6% of the earth's land surface, is composed of wetlands. Moreover Mangroves cover some 240,000km2 of coastal area, and an estimated 600,000km2 of coral reefs remain worldwide.

Wetlands support high concentration of birds, mammals, reptiles, amphibians, fish, and invertebrate species. In addition, wetlands are also important storehouses of plant genetic material and have affected the circulation system of carbon dioxide or methane of greenhouse gasses. Therefore, it is urgently necessary to monitor wetlands in all earth scales. For the purpose remote sensing is an efficient tool, in particular ASTER is expected to provide detailed landcover on wetlands because of its high resolution, multi bands, and DEM (degital elevation model).

In this study shows both the methodology for wetland mapping using ASTER data and wetland maps made by applying the method to ASTER data for two wetland sites in Japan

2. STUDY AREA

The study areas are Kushiro Mire and Iriomote Island. Vegetation in each area is completely different as follwing.

Kushiro Mire, which is organized by fen, bog, and alder, is located in lower Kushiro River basin of southeast Hokkaido, the northernmost of the four main islands of Japan and is the biggest wetland of Japan. Among organizations fen with Sedge and Reed is predominant because of eutrophication caused by being flooded all the time. Kushiro Mire is the first wetland in Japan included in the Ramsar List in 1980 when Japan was affiliated with the Ramsar Convention.

Iriomote Island, in where Mangrove forests grow all around a river mouse, is located in 400km southwest from Okinawa Island, the southernmost island of Japan.

3. METHODOLOGY AND RESULT

The algorithm for Kushiro Mire is necessary to obtain ASTER data of both thickness season and defoliation season, in case of Iriomote Island, however, the algorithm need only one scene of ASTER data because of thickness season all through the year. Table1 shows ASTER data used in this study.

Table 1. List of ASTER data.

Site	Satellite/Sensor	Acquisition date
Kushiro Mire	TERRA/ASTER	2000/06/19 , 2001/11/29
Iriomote Island	TERRA/ASTER	2000/05/08 , 2001/01/03

A process to make wetland map for Kushiro Mire is shown in Fig.1.

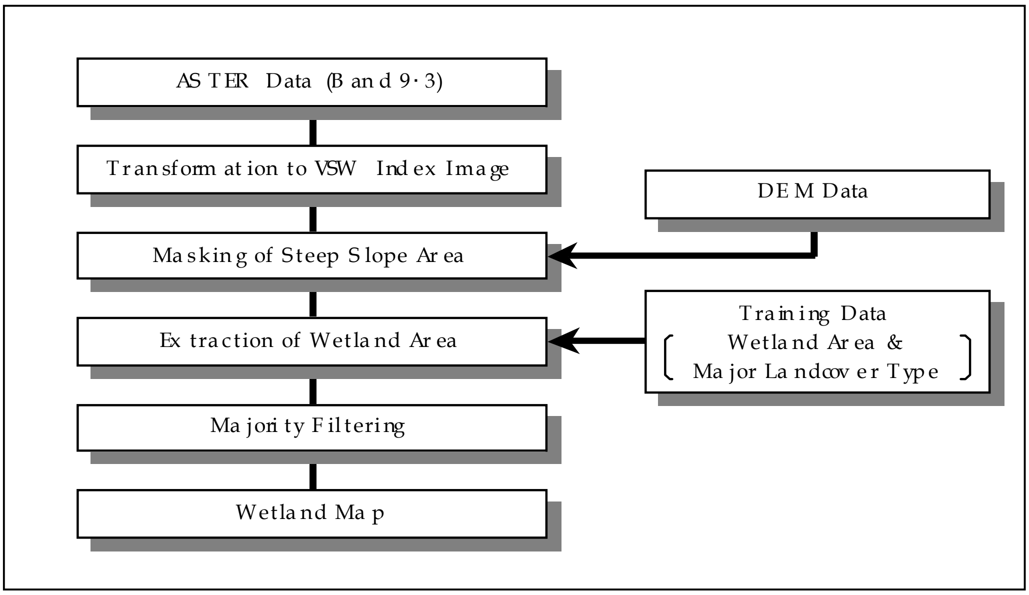

Figure 1. Flow of the method to make wetland map

3.1 Making Data Set

After a geometric correction using of a topographical map (1:50,000), ASTER data was transferred to the value of reflectance according to the result of measuring reflectance on each site. Table2 show transformation coefficient of DN value for each band according to following formula(1), calculated from 0 to 255 in proportion to the reflectance value from 0 to 1.

$$DN' = K * DN + C \qquad (1)$$

DN' : DN value after transformation
DN : DN value
K,C : transformation coefficient

Table 2. Transformation coefficient of DN value

ASTER Band	Spectral range (μ m)	Kushiro Mire				Iriomote Island			
		(2000/06/19)		(2001/11/29)		(2000/05/08)		(2001/01/03)	
		K	C	K	C	K	C	K	C
1 (VNIR)	0.520-0.600	0.663	-43.631	1.680	-42.809	0.862	-63.240	0.987	-19.258
2 (VNIR)	0.630-0.690	0.729	-28.935	1.859	-23.679	1.084	-52.148	1.306	-13.543
3 (VNIR)	0.760-0.860	1.191	-20.099	3.180	-20.199	1.589	-13.171	1.862	-14.066
4 (SWIR)	1.600-1.700	1.392	-28.180	3.573	-25.135	1.586	-5.919	2.053	33.515
5 (SWIR)	2.145-2.185	1.749	-34.382	4.531	-36.083	1.581	0.431	2.726	17.937
6 (SWIR)	2.185-2.225	1.145	-19.135	2.729	-19.375	1.293	3.618	2.114	25.355
7 (SWIR)	2.235-2.285	1.663	-31.911	4.368	-32.000	1.288	7.398	2.532	15.994
8 (SWIR)	2.295-2.365	1.584	-26.186	3.861	-21.282	1.160	10.394	2.382	15.836
9 (SWIR)	2.360-2.430	2.139	-39.788	4.144	-34.672	1.813	-1.155	4.317	2.076

3.2 Transformation to VSW Index Image

VSW index is defined as a natural extension of PVI (Perpendicular Vegetaton Index) for monitoring not only vegetation conditions but also soil and water conditions as well (Yamagata et.al, 1991,1997). PVI measures only vegetation parameters, whereas VSW index monitors vegetation, soil and water paraments simultaneously by measuring the distances on a triamgle in a NIR- Red scatter plot as shown figure2.

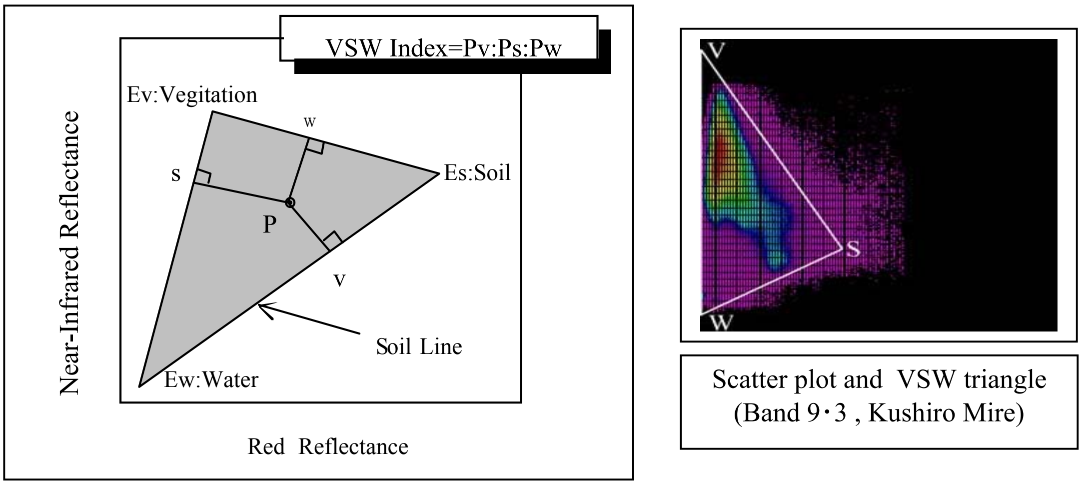

Figure 2. Concept of VSW Index, and Scatter plot and VSW triangle

After band combinations with higher separability matrix among all band combinations transformed to VSW (Vegetation-Soil-Water) index imagery, adequate band combination was investigated. Among the ASTER data band 3&9 and 3&4 were applicable band combinations for Kushiro Mire and Iriomote Island respectively.

3.3 Application of Wetland Map

By using DEM data steep slope area was removed from Vegetation because wetland never exist on thus area. Steep area in Kushiro Mire extracted from ASTER DEM was masked. In Iriomote Island, altitude area over 10m, where Mangrove never exist, was also masked by using 50m mesh DEM data made from a topographical data.

Maximum likelihood method was applied to VSW index imagery, and wetland area was extracted. And after removing tiny noise on extracted imagery by majority filtering, wetland map was finally completed.

By compared wetland map with truth data, the accuracy of extraction of wetland area for Kushiro Mire was certified 76.9%. In case of using a topographical DEM data (50m mesh) instead of ASTER DEM, the accuracy was up to 86.3 %. Figure3 shows wetland maps for Kushiro Mire we made according to this method.

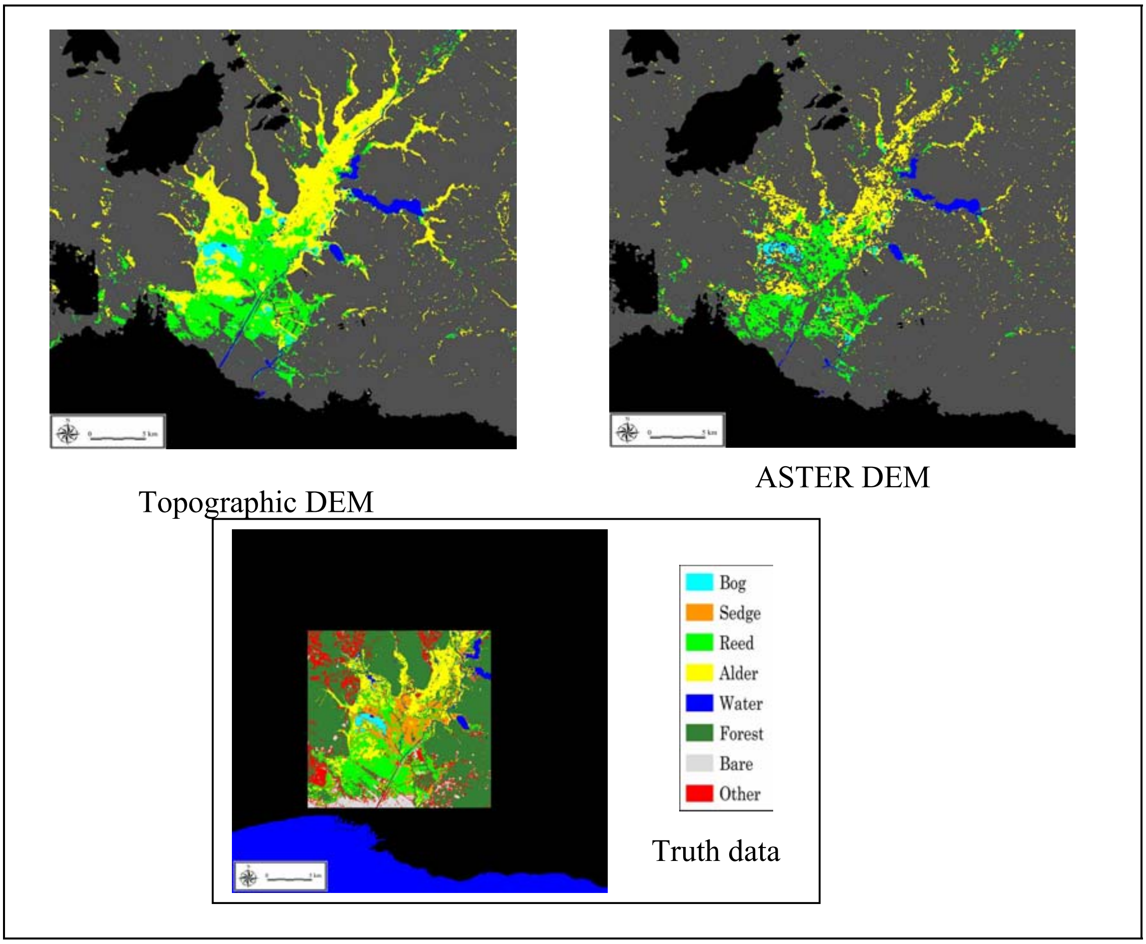

Figure 3. Comparison of wetland map for Kushiro Mire by using each DEM data

By compared two wetland maps for Iriomote Island (Fig.4) with wetland mark of a topographical map (1:25,000) as truth data, the accuracy of extraction of wetland area was certified 96.7% and 97.4%, because there were some errors that extracted as wetland besides Mangrove forests. So it is necessary to investigate a method of removing the error.

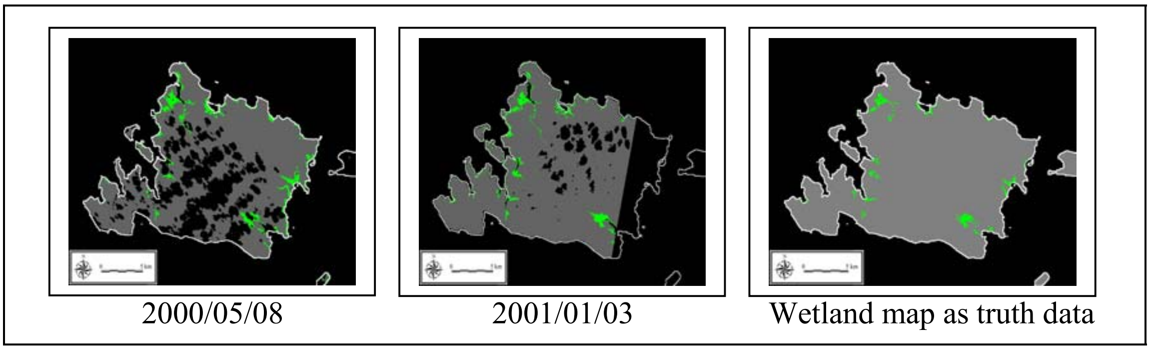

Figure 4. Comparison of wetland map for Iriomote Island

4. SUMMARY AND FUTURE WORK

In this study shows the following algorithm for making wetland map using ASTER data. Firstly ASTER data transfer to reflectance, secondly the data tranform to VSW index imagery after removing steep slope area by DEM data, thirdly maximum likelihood method is applied to the VSW index imagery. Lastly wetland area is completed after removing tiny noise by majority filtering.

The method availability was verified in this paper by applying to Kushiro Mire and Iriomote Island in Japan, which were another wetland type. ASTER DEM, which is certainly valuable, however, the accuracy of the extraction of wetland declines by more than 10%.

In order to generalize this method, it is necessary to apply to other wetland sites and to confirm its availbility, and subsequently making a wetland map on a global scale, specially in the sites of Ramsar List. Now in Japan eleven wetland sites are included in the List and are preserved carefully them to future generations regarding “wise use” as the Ramsar concept.

The term of “wise use” is meant not only to preserve wetland but also to be indebted to wetland for traditional hunting, fishing and for a tourist resort respectively. In the proper management for wise use, ASTER is expected as an effective sensor because it is possible to monitor wetland and to examine how to use the resort by using its high resolution (15m in VNIR sensor) , multi bands and DEM.

5. REFERENCES

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