MAP PROJECT OF FONGAFALE ISLAND, FUNAFUTI ATOLL, TUVALU

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1. Introduction

The map is fundamental tool for local resident and island management. Therefore the contents of the map should be updated latest information and not only the natural factors but also the artificial factors should be included. In addition it is useful for considering the adaptation that the map includes additional information that indicates the present and future influences in some fields that will be caused by the sea-level rise. Fongafale Island, target site of the project, has the simple map of facilities and topographic characteristic and the bathymetric map. However there is no map that includes the island elevation and integrates some information. In addition, the digital dataset for periodic update of the map is not adjusted for easy use. Then, this project constructed the basic map and the applied map for adaptation on Fongafale Island of Funafuti Atoll, as well as the digital dataset based on the ArcGIS.

Fundamental contents such as road, buildings, and elevation contour should be included in the daily and widely usable map. All of contents included in the basic map are able to revise easily on the general PC in which ArcGIS was installed. Even if ArcGIS is not available, the provided data can be converted to the other GIS software format easily.

Adaptation against the sea-level rise is a big subject in many fields. Although estimation and evaluation of local influence of sea-level rise are significant, it is difficult to grasp plural information without an integrated result. Then, this project constructed the applied maps for adaptation in the field of nearshore hazard, inundation, and agriculture which were based on the digital dataset. The constructed maps provide not only precious information to management officers in each field but also an example of application of the provided data of island contents. It is desired the applied map of other field which was not focused by the project will be constructed using the method conducted in this project.

2. Contents of the map

All contents described in the printed map are included in the digital data set which is constructed by Arc/GIS. Details of the contents are shown in the table 1.

Table 1 Listed contents of the map

File name	File type	Contents	Remarks
airfield	Polygon	Airport Building, Runway	It includes the data of 1943 and 2003.
building	Point	Buildings	It includes the data of 1896, 1941, 1943, 1974, 1984 and 2003.
contour	Line	Contour line of the island	It was constructed by using DEM of 1984. Up to Fuanfuti wharf.
hilia	Polygon	Inundated area	It was detected by interview.
island	Polygon	Outline of the islands	It was constructed by using the map of 1974.
mangrove	Polygon	Mangrove	It includes the data of 1986, 1941, 1943, 1974, 1984 and 2003.
pond	Polygon	Pond	It includes the shape of 1974, 1984 and 2003.
stormridge	Polygon	Ocean-side storm ridge	It includes the data of 1986 and 1984.
swamp	Polygon	Swamp	It includes the data of 1986, 1941, 1943, 1974, 1984 and 2003.
taro	Polygon	Taro pit	It includes the data of 1986, 1941, 1943, 1974, 1984 and 2003.
transects	Line	Transects	Transects were measured in 1896.
airportfacility	Polygon	Airport Building, Runway	Detected by the satellite image pictured in 2005-04-13.
coastline	Polygon	Coast line	Detected by the satellite image pictured in 2005-04-13.
contourline	Line	Contour line of the island	It was constructed by the results of both Foram Sand Project and J-PACE.
douro	Polygon	Roads	Detected by the satellite image pictured in 2005-04-13.
house	Polygon	Houses, Offices, Pig pens, etc…	Detected by the satellite image pictured in 2005-04-13.
lake	Polygon	Pond	Detected by the satellite image pictured in 2005-04-13.
reefline	Line	Reef edge, patch reef	Detected by the satellite image pictured in 2005-04-13.
landpart	Polygon	Island	Detected by the satellite image pictured in 2005-04-13.
fun0*	tif	Satellite images (Quick bird)	Pictured in 2005-04-13.

3. Construction of the basic map

Basic map includes fundamental contents for not only the officers but also the residents who are living in Fongafale Island. The map is constructed by latest and high-resolution satellite images and the measured results of field investigation by Foram Sand Project, J-PACE and SOPAC. For government officers, the basic map which includes infrastructure facilities and many of other city components is quite useful and important to discuss the land management and development strategy. For residents in Fongafale, the basic information on geomorphology such as the island elevation and the bathymetry is useful for their daily life.

The basic map is provided by two printed maps which are different framework: whole of Fongafale Island and the enlargement of the central part of Fongafale. The additional printing is easy because the digital data and printable frame work of the basic map is prepared by ArcGIS. Moreover, the each data constructing the basic map is the vector data (In ArcGIS, it is called the Shape file.) which can convert to the format used in other GIS software such as MapInfo. Then, the contents data is general and useful. Samples of the basic map are indicated in Fig. 1 and 2.

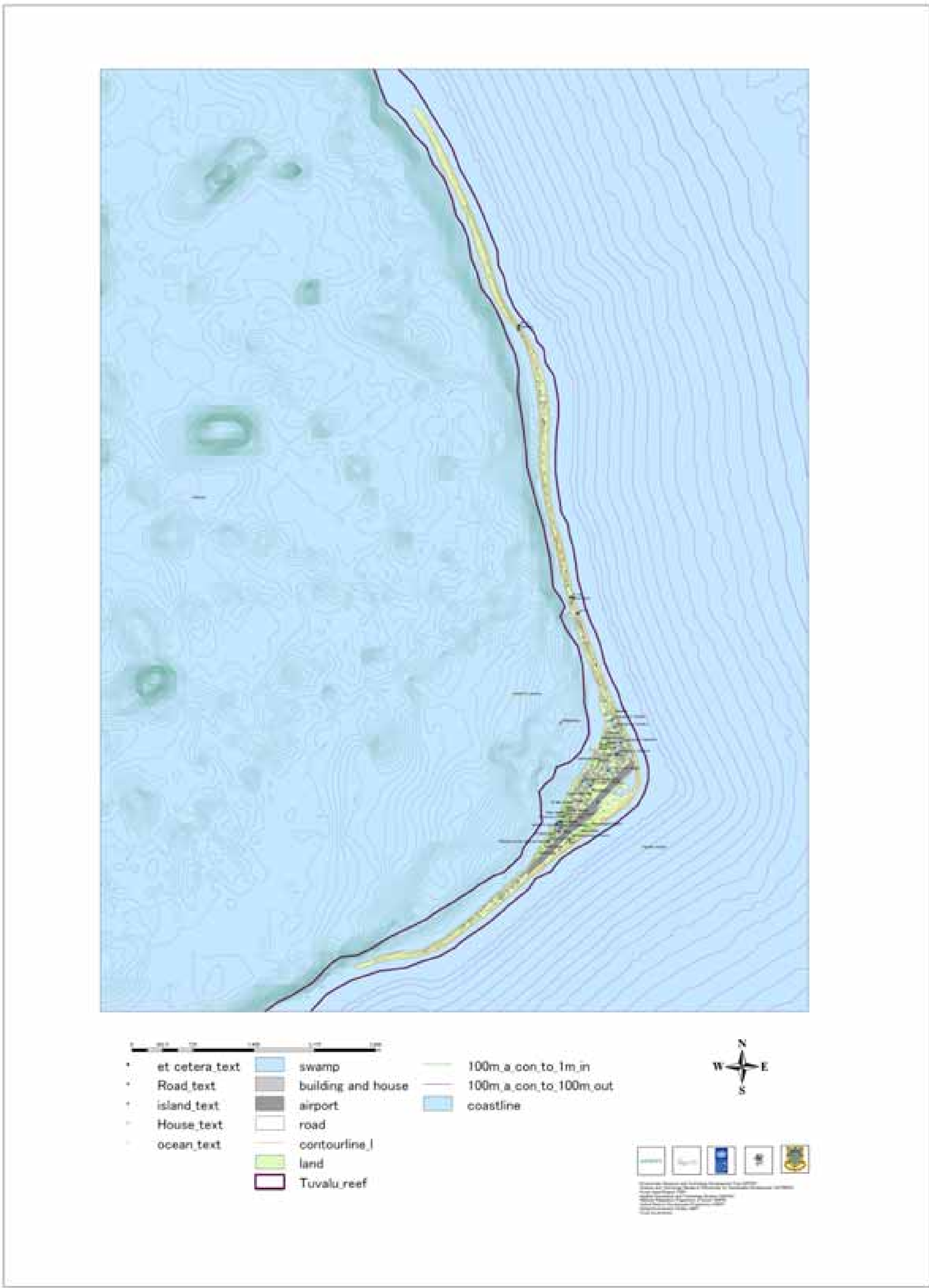

Figure 1　Basic map (whole of Fongafale Island)

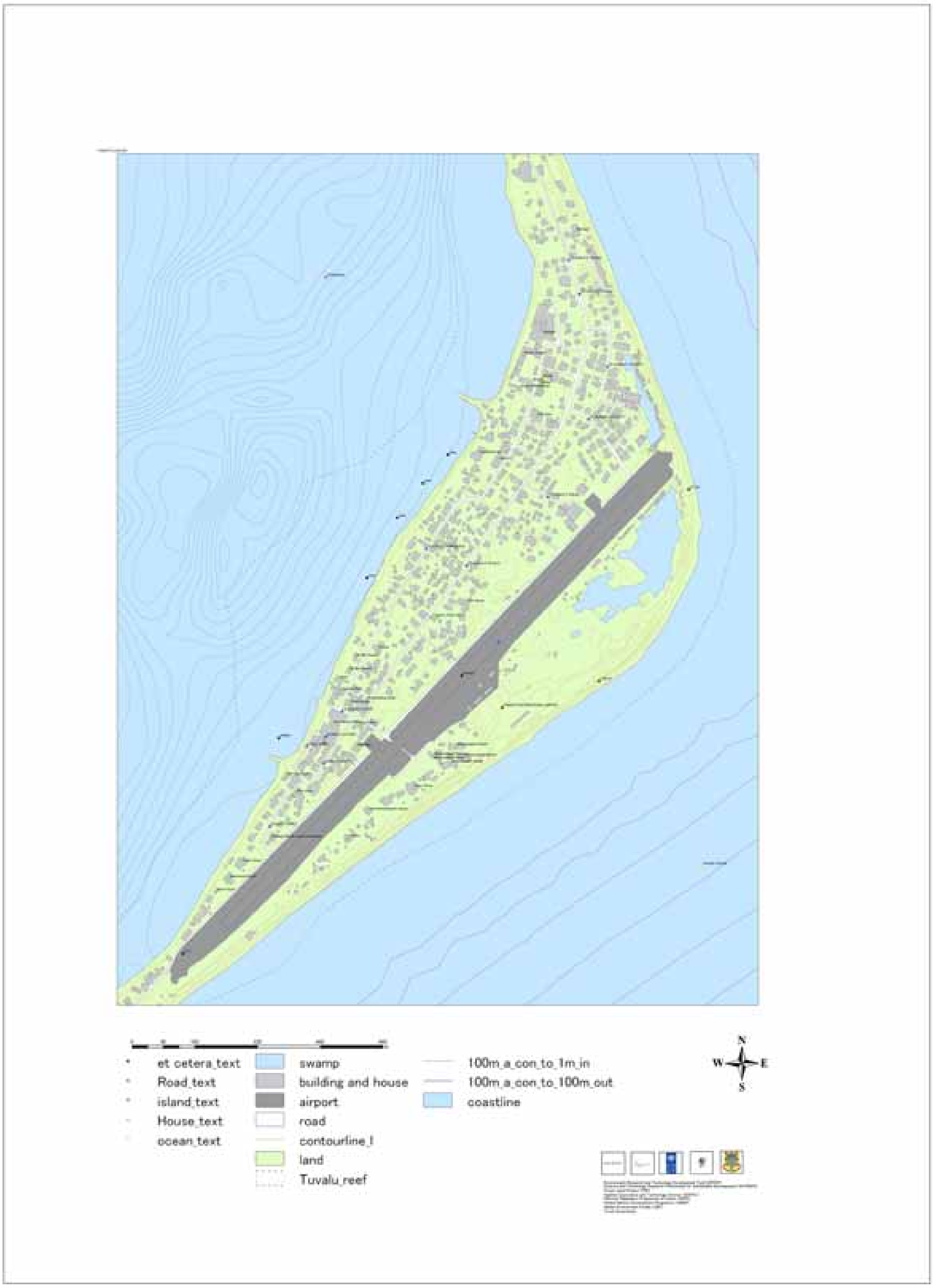

Figure 2　Basic map (enlargement of central part of Fongafale)

4. Digital data set

This section describes data handling of ArcGIS. Several operations such as the exchange of the displayed layer are easy and simple in ArcGIS. All data is prepared by WGS84(UTM ZONE60S). Layer contents installed in the ArcGIS document (.mxd) are indicated in the Fig 3. Fundamental operation of ArcGIS is indicated in Fig 4.

Layer

- 【Marginal Information】 : For setting of map output
- General drawing_frame : For setting of map output
- ForamSand_fangare_time series_GIS
  - Transects_1896
  - Stormridge_1896
  - Stormridge_1984
  - Stormridge_old
  - Taro_2003
  - Taro_1984
  - Taro_1974
  - Taro_1943
  - Taro_1941
  - Taro_1896
  - Mangrove_2003
  - Mangrove_1984
  - Mangrove_1974
  - Mangrove_1943
  - Mangrove_1941
  - Mangrove_1896
  - hilia
  - Contour_1984
  - Swamp_2003
  - Swamp_1984
  - Swamp_1974
  - Swamp_1943
  - Swamp_1941
  - Swamp_1896
  - Swamp_merged
  - Swamp_old
  - Pond_2003
  - Pond_1984
  - Pond_1974
  - Building_2003
  - Building_1984
  - Building_1974
  - Building_1943
  - Building_1941
  - Building_1896
  - Airfield_2003
  - Airfield_1943
  - Island_1974
- Et cetera_text
- Road_text
- island_text
- House_text
- ocean_text
- swamp
- building and house
- airport
- road
- contourline_l
- land
- Reefline_utm
- 100m_a_con_to_1m_in
- 1000m_a_con_to_100m_out
- contourline_p
- coastline
- Background : For setting of map output
- CHK : For setting of map output

ForamSand_logo

- mergep_1
- mergep_100
- reefline_utm
- ForamSand_logo.tif

satreps_logo

- Logo_normal_logo.tif

UNDP_Logo_logo

- UNDP_Logo.tif

gef_logo

- gef.jpg

Tuvalu_gov_logo

- Tuvalu_gov.png

Figure 3　 Installed data in ArcGIS

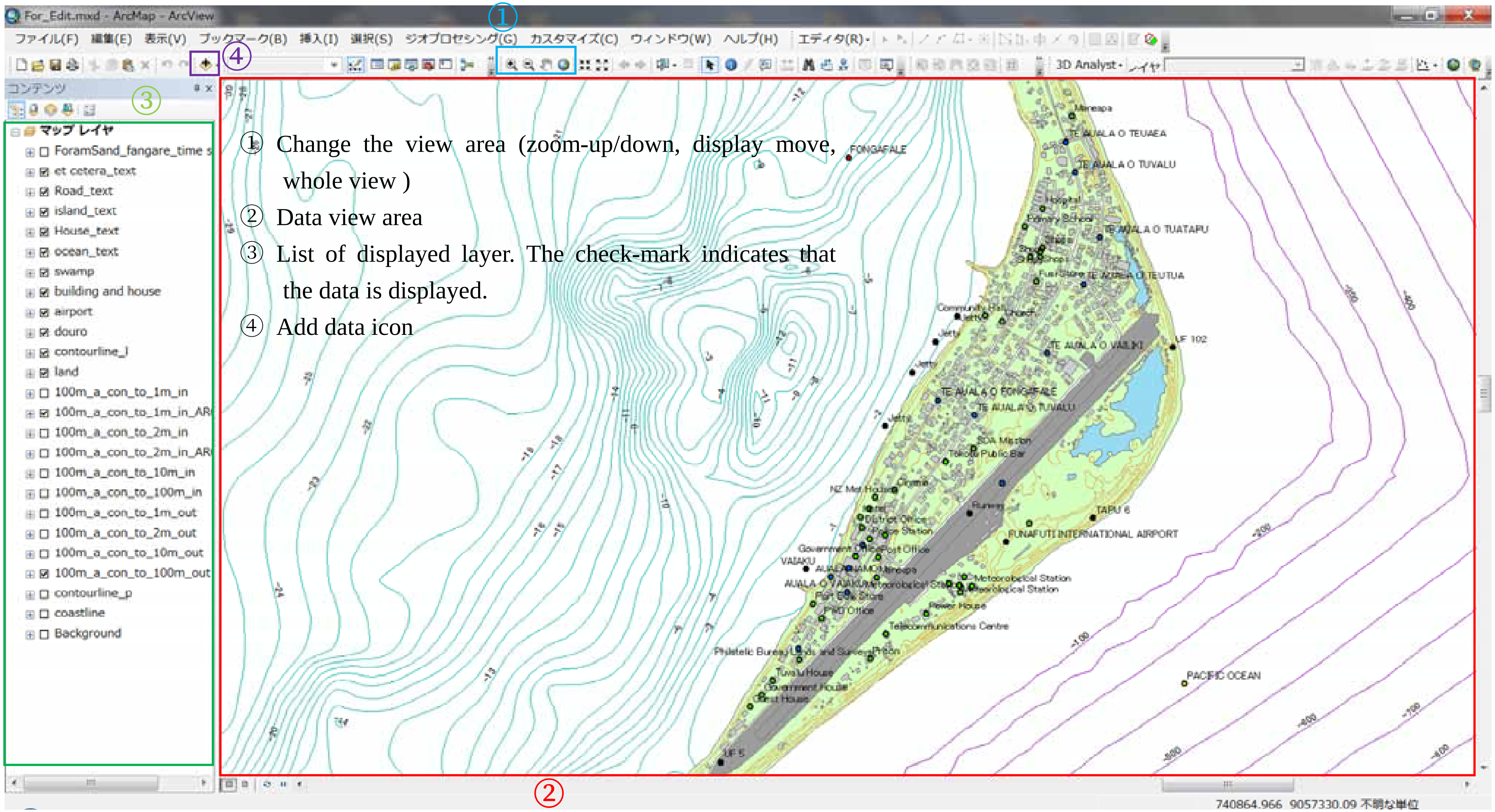

Figure 4 Fundamental operation of ArcGIS

5. Examples of application toward adaptation

This section describes the application examples of the provided map data to consider the adaptation against the sea-level rise. This project focused on the fields of the nearshore hazard, inundation, and agriculture.

5.1 Nearshore hazard

Nearshore hazard is the serious and general problem in atoll islands because almost all residents live in coastal zone. In addition, it is indicated that the sea-level rise due to the global warming will increase the nearshore wave height and it would cause the wave overtopping frequently. The map provides the basic and important information for considering the adaptation against the present and future wave overtopping (Fig 5).

This map focused on the wave overtopping, which is classified as one of the significant problems in the nearshore hazard in the atoll islands, and showed the present wave damage points and nearshore wave height, and future wave situation. Wave damage caused by the wave overtopping was reported in the lagoon-side coast of middle of Fongafale Island and the ocean-side of northern part. The difference of the materials in the lagoon-side coast seemed important for wave damage because the lagoon-side coast with wave damage has higher elevation than the nearby area and was calculated as same wave condition as nearby area. In the future, it was estimated that the sea-level rise of 10cm makes wave height increase by 1.2 times as the maximum increase rate. In the ocean-side, it is recognized that the northern part has the high wave height at the present and the high increase rate in future. On the other hands, increase rate of future wave height in the southern part of the ocean-side coast is lower than northern part. Countermeasure against the overtopping, however, should be considered in this area because the storm ridge is quite low partly.

Contents of the map

Color map of elevation	The data is constructed by the contour line of elevation which is included in the basic map.
Wave damage points	The wave damage points identified by the questionnaire survey conducted by JPACE.
The present nearshore wave height	The max wave height between the trade and non-trade wind season which was calculated by numerical simulation.
Increasing rate of wave height	Increasing rate of wave height which was calculated by the present and the future wave field. The value of sea-level rise in the future condition was considered of 10cm. 100% or more indicates that the wave height increases higher than the present situation.

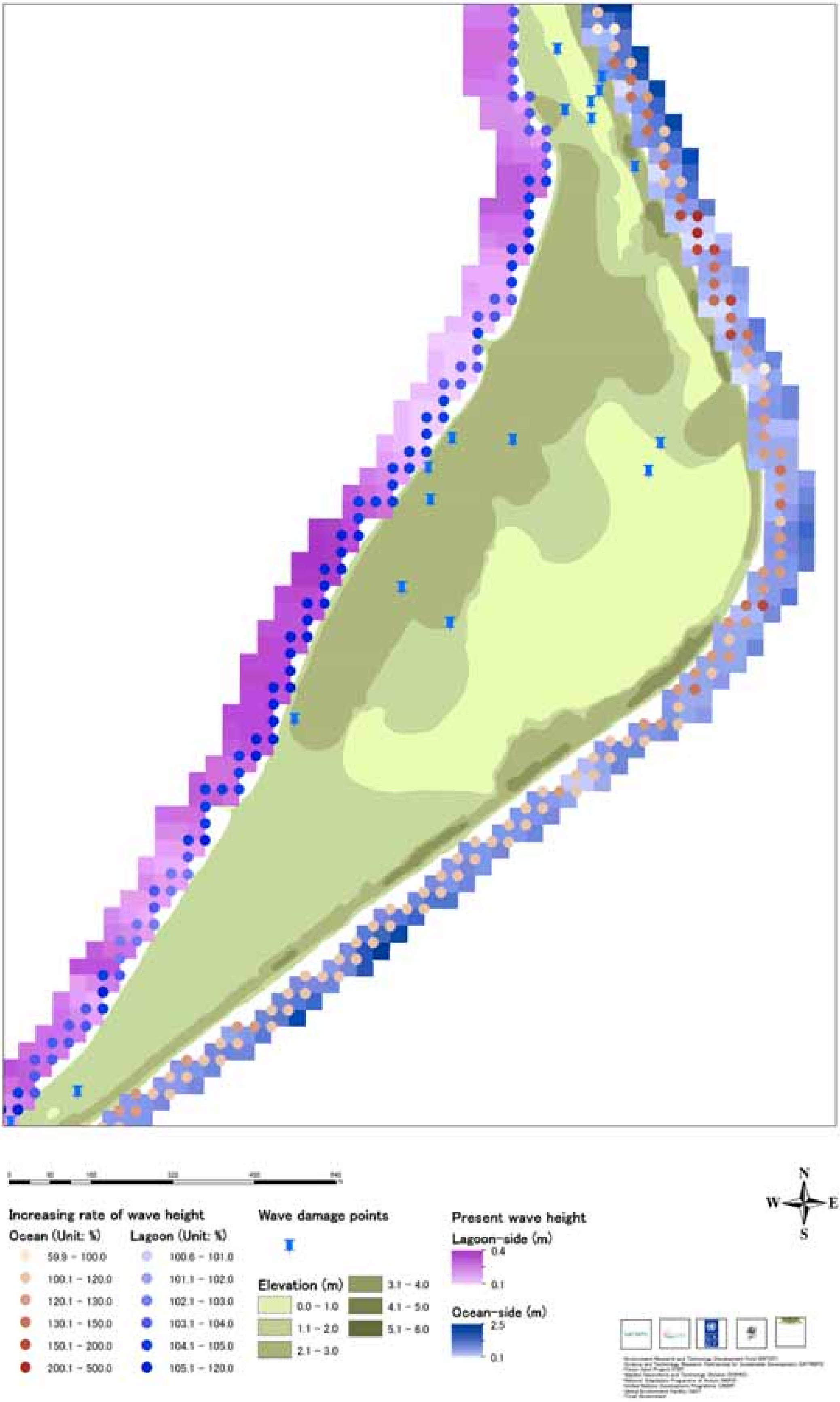

Figure 5　Applied map for nearshore hazard

5.2 Agriculture

This map focused on the adaptation on the taro cultivation (Fig 6). The present potential agricultural area extracted by the present taropit indicates that the land of the same size as the present area is in only the southern part of the airfield. In the case of the sea-level rise 10cm, the potential area in the southern part of the airfield which is indicated in the present figure disappeared. Moreover, the potential area located in the present taropit changes to unsuitable zone on taro cultivation. In the case of the sea-level rise 50cm, the potential agricultural area decreases more and more. The sea-level rise affects impact to the cultivation of taro. In order to preserve the taro cultivation continuously, arrangement of buildings and roads need to be considered in the future. Information of groundwater distribution and salinity should be included for more concrete consideration. Monitoring and accumulation of the basic data are important.

Contents of the map

Color map of elevation	The data is constructed by the contour line of elevation which is included in the basic map.
Taropit	Shape of taropit provided in the digital data of the map.
Potential agricultural area	The data indicates that the potential agricultural area extracted by the elevation range which is calculated by highest and lowest elevation of Taropit area. The figure shows the potential area except houses, roads, inundation area and airfield. The map includes the result of three cases that are the present, SLR(+10cm) and SLR(+50cm).

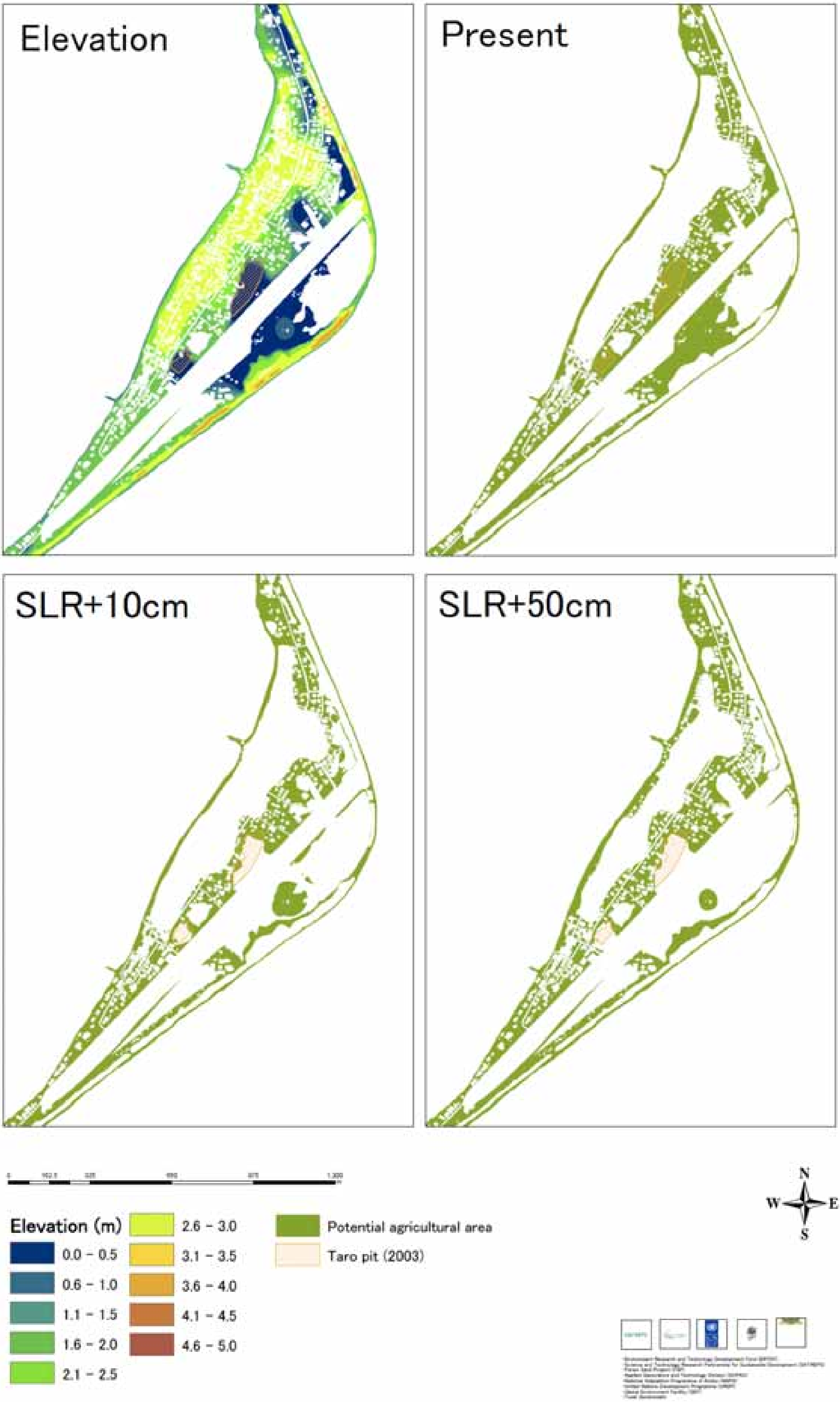

Figure 6 Applied map for inundation

5.3 Inundation

This map focused on the adaptation against the inundation (Fig 7). The potential inundation area which was analyzed based on the elevation and present inundation area was provided in the map. The area around the airfield is as same elevation as the present inundation area and belongs to the potential inundation area. The sea-level rise expanded the potential inundation area toward higher elevation. The results provide fundamental information for constructing the future construction management plan of housing and facilities.

Calculated potential inundation area is extremely larger than the present inundation area, because of lack of information such as the source and speed of inundation. Higher accurate evaluation needs the detailed monitoring of inundation.

Contents of the map

Color map of island	This data indicates material of the island (island shape, road, airfield and pond).
Inundation area	The data indicates inundation area which was measured by local residents of Tuvalu.
Potential inundation area	The described data was calculated by the highest inundated elevation which was extracted by using the present inundation area. This data was constructed based on the assumption that the island area below the extracted elevation has potential of inundation. The results about present, SLR(+10cm), and SLR(+30cm) were provided in the map.

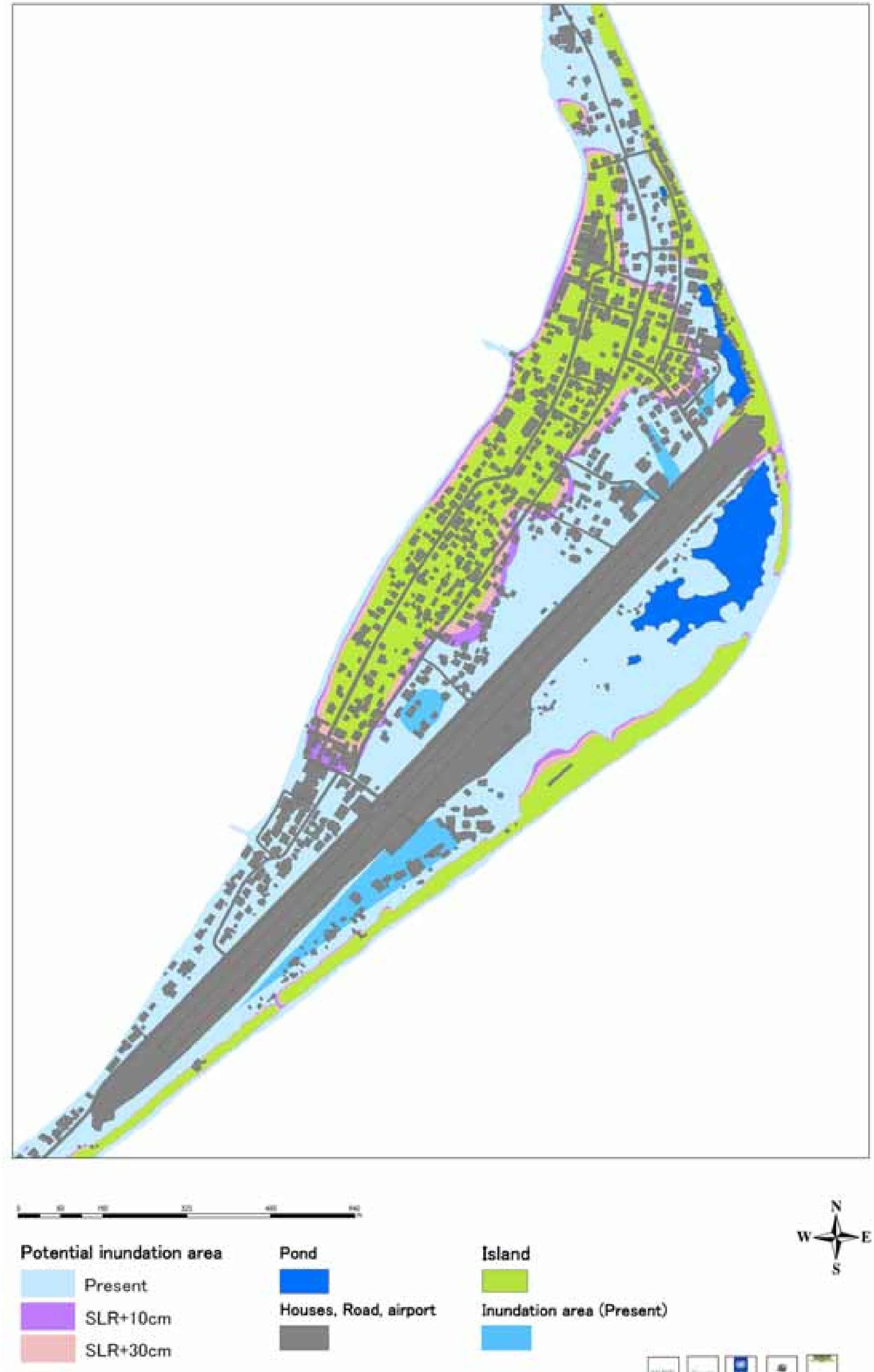

Figure 7　Applied map for agriculture

6. Conclusion

This project provided the fundamental map that includes elevation contour and facilities and infrastructure in addition to the map adoptable to considering the adaptation. In addition, the digital data which is formed by not only the data included in the fundamental map but also the historical data of pond, mangrove, elevation, buildings, and taropit was provided by the ArcGIS format. It is easy to add the new and revised data to the digital dataset. Then, the digital dataset should be revised periodically by local officers. Topographical and infrastructural data is essential information for all of residents in Fongafale Island. And the latest situation of these data needs to be understood. Periodic and continuous update of the map data is desired strongly.

Acknowledgement

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