

ESTABLISHING AN ENVIRONMENTAL DATA PLATFORM FOR PROMOTING COASTAL ZONE ENVIRONMENTAL MANAGEMENT

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ABSTRACT:

This paper reports a standardization activity for coastal environmental information in Japan to promote the sharing of various spatial data among related parties, including data specifications, designs of software tools to create and utilize data based on the ISO/TC211 standards, and a case study of its implementation as a web-based information system. It has become possible for “everyone” to “easily” obtain environmental information by using this system. As a result, cooperation between related organizations is also promoted and effective environmental management can be achieved. It is anticipated that this system will provide enough environmental information to practice environmental policies, and help consensus building among a wide range of stakeholders. It is also expected that this system will promote research and development for environmental improvement measures for enclosed coastal areas such as Tokyo Bay.

1. INTRODUCTION

Various organizations have been dealing with infrastructure improvements in Japan. Therefore, we are able to enjoy a convenient and pleasant living environment. However, as the infrastructure improvements focused on quantitative fulfilment, mass production, mass consumption and mass disposal style socio-economic activities and lifestyles have taken root. As a result of this, various environmental problems are currently emerging such as air-pollution, water-pollution, increased waste and a reduction of living organisms. Japan, which is surrounded by sea on all sides, is blessed with fish and mineral resources from the sea and takes advantage of the qualities of the coastal areas and utilizes them as places for industry and recreation. So, we must implement management (adaptive management including the PDCA: Plan Do Check Action cycle) suitable to the environment after grasping an accurate understanding of the current environment in order to pass it on to generations to come and resolve environmental issues in a desirable way. Moreover, the environment continues to change hour by hour. Consequently, if one is to grasp an understanding of the coastal zone environment, it is essential to gather a wide range of environmental information about the various living creatures and the inanimate objects in the ample area from the land to the coastal zone. Accordingly, until now, environmental research has been continuously carried out mainly by administrative bodies such as the national and regional municipalities and the implementation of environmental improvement projects and regulations. Furthermore, recently citizens' knowledge of environmental issues has heightened, environmental education is being carried out and there is active participation in environmental improvement activities.

Despite each body being actively involved in environmental improvement, it seems that there are no results produced for the realization of an environment that we deem as desirable, for example results such as, water-purification and increase of biodiversity. The supposed reasons for this are identified as follows.

(1) Many bodies for their environmental objectives use independently obtained data. Thus, even in the same coastal zone, effectiveness of management cannot be wholly evaluated because the initiative has not been unified.

(2) To begin with, the details of the initiatives are not being fully explained to local residents and related parties.

(3) The current problems and necessary initiatives are not enough to be understood by local residents and related parties. Thus, effective environmental improvement projects are not being carried out.

Therefore, in order to implement more effective environmental management at an earlier stage, it is important for the various bodies to share information and to deal with environmental improvement upon consulting on consensus building for environmental objectives and values. However, the issues which arise at the time of environmental data sharing are listed below.

(1) As the whereabouts of environmental data is unclear, the existence and inquiries of information is not identified.

(2) As data is defined by each body carrying out research and the definitions are not inconformity, it is not easy to share data.

(3) For the environmental data being disclosed, there are many records of only the final figure, and the method of creating the data (examination tools and analysis methods etc.) is unclear. Thus, if the method of creation is not confirmed then it cannot be compared with other data.

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Accordingly, the Ministry of Land, Infrastructure and Transport Kanto Regional Development Bureau Yokohama Research and Engineering Office for Port and Airport (hereinafter referred to as the Ministry of Land, Infrastructure and Transport) developed a web-based information system for sharing the valuable environmental data gathered thus far by the each body.

2. CONCEPT OF STANDARDIZATION AND INVESTIGATION MATTERS

2.1 Concept of Standardization

The method used for sharing environmental data has been to share data format, measurement methods, analysis methods and instrumentations. On the other hand, the standardization of the environmental data, examined in this study, is aimed at sharing the data structure in order for information to be shared between various bodies. Since environmental data possess coordinates on the globe, it can be treated as a form of “geographic information”. In connecting with this “geographic information”, “data structuring definition” work is being carried out from among the ISO/TC211, if this is applied then environmental data may be standardized in the same way as other geographical information. The ISO/TC211 considers that “geographic information comes from geographic feature data and metadata”. Geographic feature data is considered to be environmental data obtained through practical study such as analysis values and observation values and metadata is data attributes, content, information acquisition source and storage location and is characterized as data used for explaining environmental data. Therefore, the metadata taken up in this study has been structured to permit representation of the outline of the environmental data based on the JMP2.0 (JapanMetadataProfile2.0) (Geographic Survey Institute, 2003), which is domestic metadata specifications conforming to the ISO/TC211 (ISO/TC211, 2003). In addition, the environmental data has been structured based on the data structure in ISO/TC211 (ISO/TC211, 2007).

2.2 Standardization Investigation Matters

ElementName	Definition	Obligation/Condition	Maximum occurrence
Environmental Data Title	unique identifier for the dataset	Mandatory	1
Cruise Information	name of ship and cruise project	Optional	1
Abstract	brief narrative summary and purpose of the content of the dataset	Mandatory	1
Point Of Contact	identification of and means of communication with person and organizations associated with the dataset	Mandatory	n
observation Items	name of observation items(ex.WaterTemperature)	Mandatory	n
Observation Points	observed position with coordinate of the dataset	Mandatory	n
Observation Areas	observed area with coordinate of the dataset	Mandatory	n
Reference	description of the spatial reference systems used in the dataset	Mandatory	1
Observation Date	period of the observation	Mandatory	n
Format	description of the computer language construct that specifies the presentation of dataset	Optional	n
Distribution Information	information about the distributor of and options for obtaining the dataset	Optional	n
Quality Information	information about an event in the creation process for the dataset	Optional	n
Language	language used for documenting dataset	Mandatory	1
Description	text description of the dataset	Optional	1
Point Of Contact (Metadata)	party responsible for the metadata information	Mandatory	1
Date Of Metadata Creation	date that the metadata was created	Mandatory	1
Language(Metadata)	language used for documenting metadata	Mandatory	1
Point Of Contact (Result)	party responsible for the result of using dataset(ex.article)	Optional	n
Format Of Result	description of the computer language construct that specifies the presentation of the result of using dataset	Optional	n
Distribution Information Of Result	information about the distributor of and options for obtaining the result of using dataset	Optional	n

Table 1. Scheme of OOMP

2.2.1 Metadata Structuring: Since the purpose of the metadata is to explain the environmental data, it must allow users to examine the necessity of the environmental data. Therefore, questionnaires were sent out to users of the environmental data on sea areas and interviews were conducted, while a review meeting was held including academic experts in the field of sea area environment, to set metadata items that would permit judgment of the possibility of utilization by users. Metadata items were set based on the JMP2.0, and some intrinsic items that showed the outline of the environment data were added, to make the OOMP (Oceanographic Observation Metadata Profile). (Ministry of Land, Infrastructure and Transport, 2004). Table 1 shows the outline of the OOMP.

2.2.2 Environmental Data Structuring: The first task to be done to advance the standardization of environmental data is to systematically organize the data structure. As shown in Figure 1, the systematic organization of the data structure involves extracting the common sections (elements) from the data groups, and structuring the data while identifying the relation between the elements.

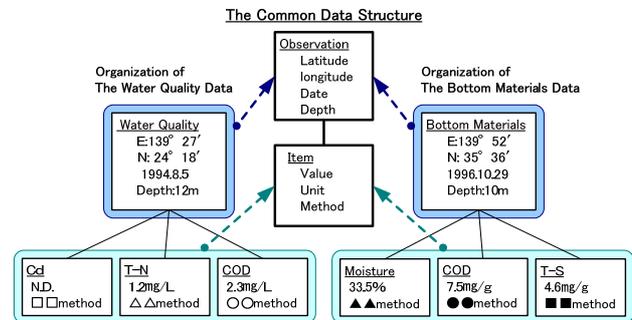


Figure 1. Data Structuring

ElementName	Definition	Obligation/Condition	Maximum occurrence
projected observation point	projected coordinate of observation point	Mandatory	n
projected observation line	projected coordinate of observation line		n
projected observation area	projected coordinate of observation area		n
definition of observation item	name of observation item	Mandatory	n
definition of unit	units using dataset	Mandatory	n
definition of instrument	information of observation instrument	Optional	n
information of calibration	information of calibration about observation instrument	Optional	1
definition of method	information of observation method	Optional	n
observation point	observed coordinate of observation point	Optional	n
observation line	observed coordinate of observation line		n
observation area	observed coordinate of observation area		n
time instant	observation date and time	Mandatory	1
time period	range of observation date and time		1
organization	organization of observation	Mandatory	1
reference system	description of the spatial and temporal reference systems used in the dataset	Mandatory	1
location determining method	method of determination of observation point	Optional	1
depth instant	the depth which the observation had been conducted	Optional	1
depth extention	the depth between upper level and lower level which observation had been conducted		1
water depth	water depth at observation point	Optional	1
observation category	category of observation item (water quality, bottom material)	Mandatory	1
value	observed value	Mandatory	n

Table 2. Scheme of CML

Based on the result, the items that should be described as the environmental data, as well as their relations, were structured based on the UML (Unified Modeling Language) and a class diagram was created. The authors examined the validity of the data structure based on the class diagram in question together

with the academic experts in the field of sea area environment to draw up standard specifications (explanation of data structure) of the environmental data (hereinafter referred to as the "Environmental standard data"). The standard specifications of the environmental standard data were named the CML (Coastal and Estuarine Markup Language) (Ministry of Land, Infrastructure and Transport, 2004). The outline of the CML is shown in Table 2.

2.3 Data Creation

2.3.1 Metadata Creation: The JMP2.0 stipulates the creation of metadata in the XML (eXtensible Markup Language) format. Creation of metadata in the XML format has been regularized also in the OOMP that is an extension of the JMP2.0. As shown in Figure 2, XML is information language that describes text form and qualified information by surrounding part of the text by a "tag". The following are three properties of XML.

- (1) It can present a section of data by surrounding it with "tags".
- (2) Tags can be freely configured.
- (3) It can be read by humans and systems.

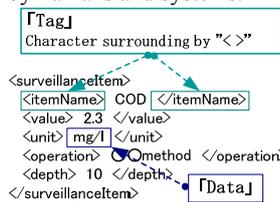


Figure 2. Description Method for XML Text

We have been developed a tool using the excel macro to create metadata based on the OOMP. The tool will permit creation of metadata without any knowledge about XML. The image of the metadata creation tool is shown below.

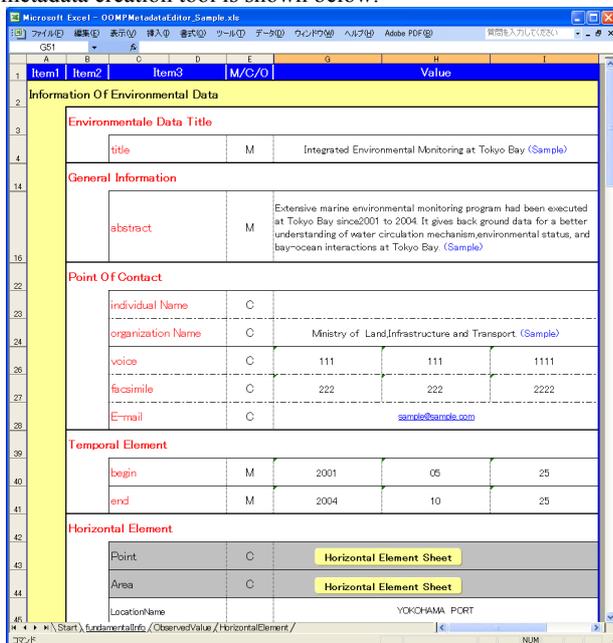


Figure 3. Metadata Creation Tools

2.3.2 Environmental standard Data Creation: Although environmental standard data is created based on the standardized data structures, if users create environmental data using their own formats then it is necessary to comprehend the

format of the data in order to share it. The ISO/TC211 recommends that XML be used for geographic feature data format. Therefore, use of the XML format has been regularized also for creation of environmental standard data. A variety of environmental observations have been conducted currently, and in many cases, the respective observation results have been arranged in formats unique to respective engineers who arrange the environmental data. Excel is used for the most part of such formats. Then the observation modes are classified into three, and the respective sheet forms of excel files have been stipulated (as shown below).

- (1) Observation carried out by continuously changing the depth
- (2) Observation carried out continuously at a constant point
- (3) Observation of living organisms

A macro has been added to the three excels corresponding to the above-mentioned observation modes to provide a conversion tool used to change data into the environmental standard data. After observations, the results should be recorded in either one of the three tools to automatically create the environmental standard data. The image of the environmental standard data creation tool (for observation carried out by continuously changing the depth) is shown below.

Figure 4. Environmental Standard Data Creation Tool

Meanwhile it is very effective for promotion of data sharing to change the long-term observation by specific equipment, as well as such data as has been collected by an on-going continuous observation and made into a database in an original format, into the environmental standard data. Under such a circumstances, efforts have been made to select instruments (multi-parameter water quality meter and ADCP), develop a conversion tool that will change data into the specific environmental standard data corresponding to the output data format, and develop a tool that will convert the public water monitoring data, which has been conducted since the 1970s by the Ministry of the Environment, into the environmental standard data. The Ministry of Land, Infrastructure and Transport is observing the surface current in Tokyo Bay in real time with the help of an ocean radar, emitting radio waves from a land-based antenna and receiving and processing the reflected echoes to continuously observe the current (direction and velocity) and waves (height, period, and direction) near the sea surface that is tens of square kilometers wide. Therefore, a tool

to convert such data into the environmental standard data has been developed. These tools and data are provided free of charge by the Tokyo Bay Environmental Information Center described later. The flow of creation of environmental standard data is shown in Figure 5.

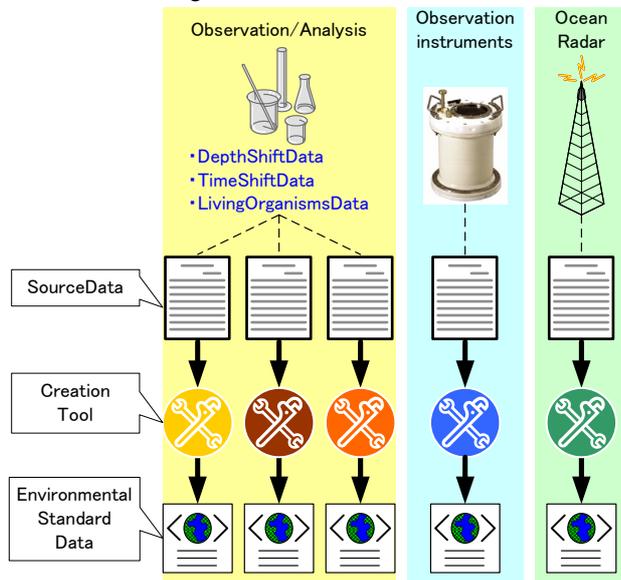


Figure 5. Creation of Environmental Standard Data by XML

3. DEVELOPMENT OF “TOKYO BAY ENVIRONMENTAL INFORMATION CENTER” WEBSITE

3.1 Overview of the Tokyo Bay Environmental Information Center

The Ministry of Land, Infrastructure and Transport commenced operation of the “Tokyo Bay Environmental Information Center (TBEIC)” website (URL: <http://www.tbeic.go.jp>) in June 2003, as a spatial data infrastructure for sharing environmental data regarding Tokyo Bay. Figure 6 shows a conceptual figure of the Tokyo Bay Environmental Information Center (hereinafter referred to as the center). In the center, the “contents aimed at information disclosure” and “contents aimed at information sharing” are being built up. The main contents are as shown below.

“Contents aimed at information disclosure”

- (1) Contents of accumulated environmental data regarding Tokyo Bay retrievable by GIS.
- (2) Environmental study contents aiming at improving awareness of the environment and developing environmental improvement activities.
- (3) Contents that can be freely registered such as details of environmental improvement events and photographs related to the environment.
- (4) Contents which can obtain, in real time, the observation results of ocean radar continuously observing Tokyo Bay.

“Contents aimed at information sharing”

- (1) Contents that retrieve and display the details and whereabouts of environmental data controlled by the various bodies. (clearinghouse)
- (2) Contents that provide tools to create and utilize environmental standard data and the standard specifications of the environmental data recommended by the center.

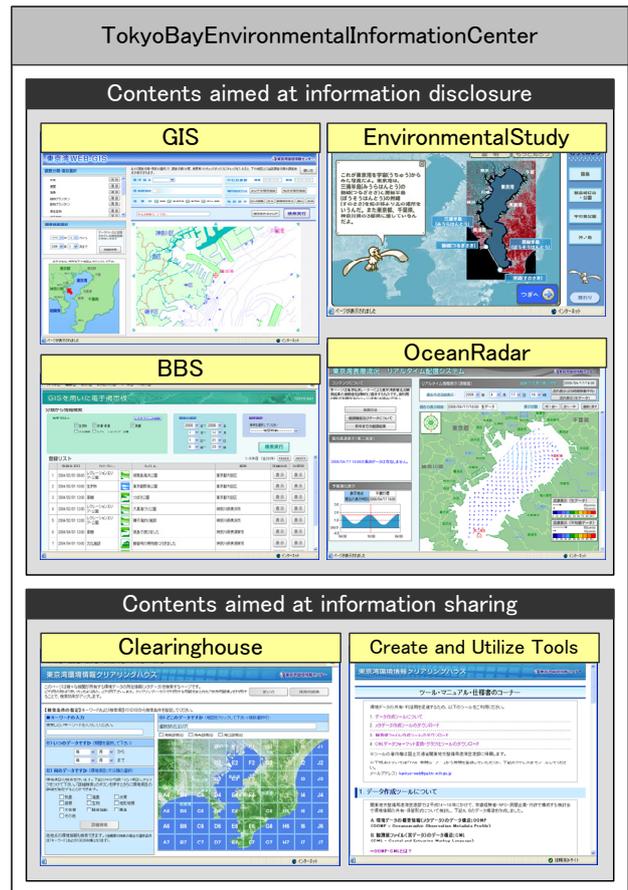


Figure 6. The Conceptual of the TBEIC

The details of the clearinghouse that will be the foundation of data sharing are described below.

3.2 Overview of the Clearinghouse

In order to promote the sharing of environmental data it is important to have a mechanism where essential information can be easily obtained. In many of the databases constructed thus far for sharing environmental data, the data has been aggregated and controlled in one database. However, the problems related to constructing a database in such a way are listed below.

- (1) The format of environmental data differs according to the data management body.
- (2) Rules are necessary to define rights and responsibilities relating to environmental data.
- (3) Vast amounts of labour are necessary for maintenance and update of environmental data.
- (4) Each body is providing their own environmental data. Accordingly, in order to resolve these issues the Ministry of Land, Infrastructure and Transport has created a clearinghouse at the center, as shown in Figure 7, as a content which can retrieve the location of the environmental data which the various bodies possess.

The clearinghouse only possesses the metadata which explains environmental data. In addition, environmental data is data managed by each body that obtains it and provided to data users. The volume of data is less in comparison with existing highly concentrated databases due to this structure. Accordingly, the burden of supervisors is reduced and it will be possible to develop a system taking into account the intellectual property rights of data creators. Furthermore, as the clearinghouse is

constructed on the internet, users can retrieve information at any time.

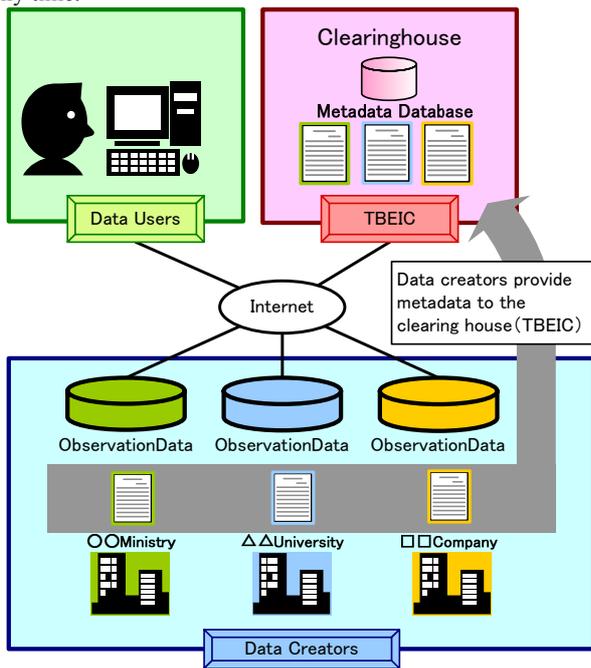


Figure 7. The Conceptual of Clearinghouse

3.3 Clearinghouse Utilization

As illustrated in Figure 8, the concrete flow of environmental data procurement by the clearinghouse can be explained by separating it into the “retrieval process” which retrieves the location of essential environmental data and the “procurement process”.

“Retrieval Process”

- (1) Users refer to the clearinghouse to check for required environmental data.
 - (2) Clearinghouse provides metadata matching the requirements.
- “Procurement Process”
- (3) Data users select the required environmental data from the metadata provided by the clearinghouse.
 - (4) Data users request the required environmental data to the creators who possess the data.
 - (5) Data users receive environmental data from the data creators.

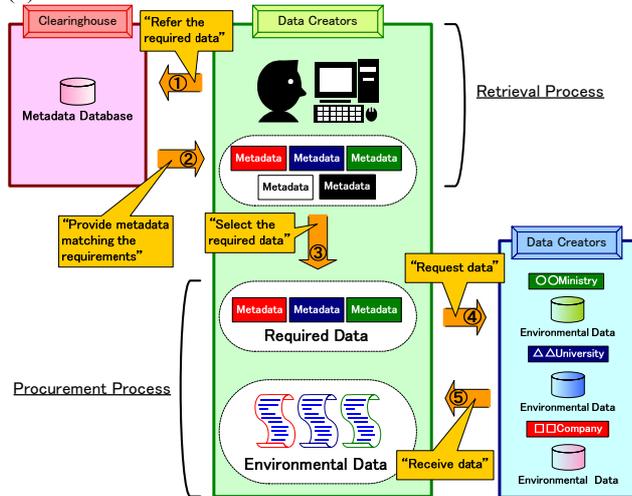


Figure 8. Clearinghouse Utilization

3.4 Use of Standard Data

The clearinghouse will clarify the whereabouts of the necessary data, permitting its acquisition through the shortest channel. When progress is made in future toward creation of the environmental standard data based on the CML examined by the Ministry of Land, Infrastructure and Transport, users can obtain the environmental standard data from various data management bodies. Users will integrate or extract obtained data to achieve respective results, but data processing will require labor because the obtained data are in the XML format. Therefore, the Ministry of Land, Infrastructure and Transport is developing and offering the “environmental standard data utilization tool (hereinafter referred to as a utilization tool)” that will support users’ efforts to process the data collected from various data management bodies after integration and extraction of those data without regard to the data format. The outline of the tool is shown below.

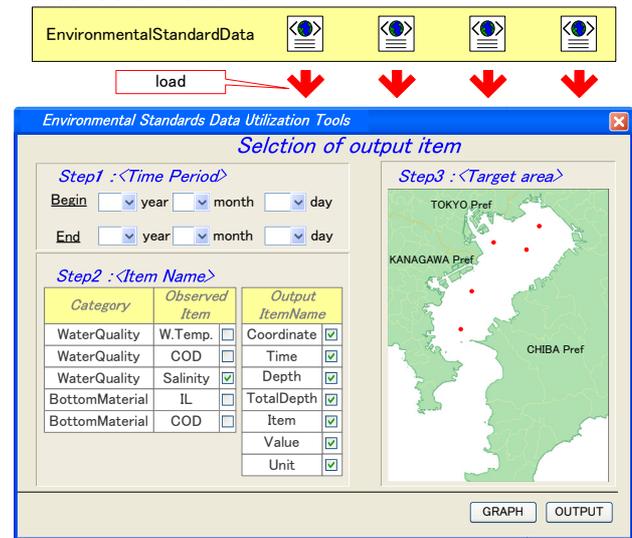


Figure 9. The Conceptual of Utilization Tools

Users will first load multiple environmental standard data into the utilization tool, and the utilization tool will read the contents (investigation item and location) of the loaded data and display a list. Users select the information to be extracted from the list. Finally, as shown in Figure 10, users specify the output format (excel, CSV, etc.) to output the information.

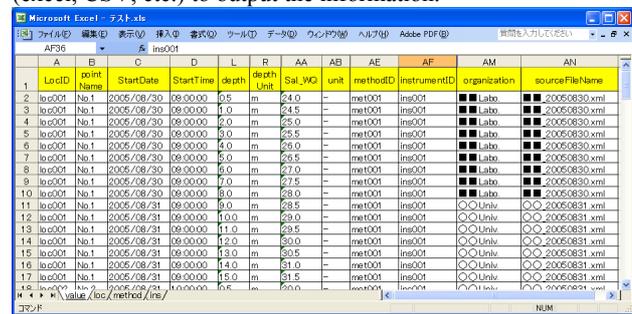


Figure 10. Extracted data by utilization tool (excel format)

This tool can also draw four types of graphs listed below.

- (1) Vertical graph
- (2) Bar graph
- (3) Sequential line graph
- (4) Scatter graph

After selecting the information to extract, users will specify the type of graph to display. For example, the vertical graph is shown below.

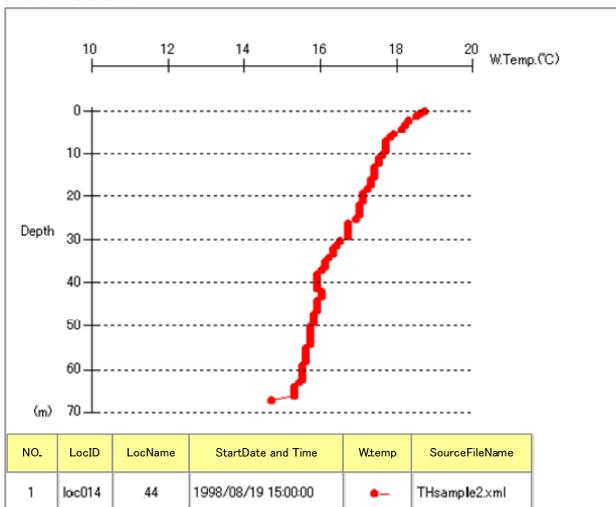


Figure 11. Vertical graph

4. ANTICIPATED RESULTS OF INFORMATION SHARING

It is anticipated that by sharing information in this way, various bodies (governments, research institutes, private companies, NPOs etc.) will be able to obtain information equally and there will be increased opportunities to discuss problems or issues arose.

At present, starting with the general environment of the coastal zone, diversification of the evaluation of information sharing is advancing and it has become a situation in which the previous type of one-sided evaluations from businesses are not acceptable. In other words, cooperation will occur due to various bodies equally obtaining information and by firstly drafting valid counter-measures and appropriate consensus building, and the realization of counter-measures will become possible.

From here on, management to ascertain how to reduce the burden on the environment, the specifics of the past and current environment in the coastal zone and to control the environment is required for continuing work in Japan's coastal areas. It is necessary to promote the following approaches by using standardization and the clearinghouse of environmental data for that.

- (1) Anytime and anywhere, the person who needs information can obtain intelligence.
- (2) The administrative body and the local populace use the same information, and communications are activated.
- (3) It works for the environmental service based on the accurate intelligence.

Utilizing this structure will develop a situation in which everyone can share environmental data and it is expected to be able to qualitatively improve environmental improvement technology and analysis techniques related to environmental impact assessments which accompany the setting of environmental improvement targets and work in response to the conditions at the time.

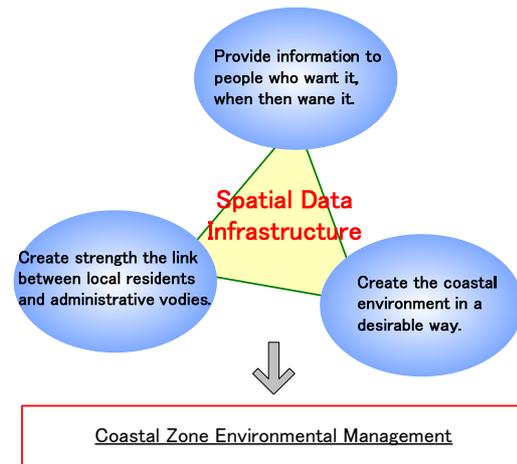


Figure 7. Implementation of Effective Environmental Management by Using the Spatial Data Infrastructure

5. CONCLUSION

In order to share environmental data that “everyone” can “easily” utilize, it is necessary for as many bodies as possible to understand the initiative and participation.

At present this information sharing structure is also being used for the Japanese enclosed coastal areas of Osaka Bay, Ise Bay, the Seto Inland Sea as well as Tokyo Bay.

Furthermore, as this kind of environmental data sharing structure can also be utilized for the environmental data of land areas in addition to coastal areas, from hereon we also think that by understanding this environmental data sharing structure and widely disseminating it, many researchers will contribute to the implementation of sustainable national land improvement.

References

- Geographical Survey Institute, 2003. Japan Metadata Profile (JMP) 2.0 (in Japanese) <http://zgate.gsi.go.jp/ch/jmp20/jmp20.html> (accessed 23 Apr. 2008)
- ISO/TC211, 2007. ISO19136 - Geographic information – Geomatics
- ISO/TC211, 2003. ISO19115 - Geographic information – Metadata
- Ministry of Land, Infrastructure and Transport, 2004. Coastal and estuarine Markup Language (CML) (in Japanese) http://www.tbeic.go.jp/ch/CHManual/CH_pro.html (accessed 23 Apr. 2008)
- Ministry of Land, Infrastructure and Transport, 2004. Oceanographic Observation Metadata Profile (OOMP) (in Japanese) http://www.tbeic.go.jp/ch/CHManual/CH_pro.html (accessed 23 Apr. 2008)