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THE ISLAMIC REPUBLIC OF IRAN

JAPAN INTERNATIONAL
COOPERATION AGENCY

ANZALI WETLAND

ECOLOGICAL MANAGEMENT PROJECT

IN THE ISLAMIC REPUBLIC OF IRAN

MONITORING MANUAL

FOR THE ADAPTIVE MANAGEMENT OF

THE ANZALI WETLAND

JULY 2012

DOE Project Team – DOE

JICA Expert Team – JICA

Monitoring Manual
For The Adaptive Management Of
The Anzali Wetland

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Anzali Wetland Ecological Management Project in the Islamic Republic of Iran

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The Islamic Republic of Iran
The Anzali Wetland Ecological Management Project

Monitoring Manual for the Adaptive Management of the Anzali Wetland

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Attachment 1: Selection of Indicators with Criteria

Attachment 2: Method of Data Analysis

Attachment 3: Sample Report of Monitoring for Anzali wetland management committee meeting

List of Abbreviations

AWMC	Anzali Wetland Management Joint Committee
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
CRM	Certified Reference Materials
DO	Dissolved Oxygen
DOE	Department of Environment
E.C.	Electric Conductivity
Eh	Redox potential
GCHHTO	Guilan Culture, History and Handicraft Tourism Organization
GIS	Geographical Information System
GRWO	Guilan Regional Water Organization
GWWC	Guilan Water and Wastewater Company
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
MOE	Ministry of Energy
MOJA	Ministry of Jihad-e-Agriculture
NGO	Non-governmental Organization
NIWAI	National Inland Water Aquaculture Institute
OJT	On-the-job Training
PMO	Port and Maritime Organization
PCA	Principal Component Analysis
QC/QA	Quality Control Quality Assurance
RWWC	Rural Water and Wastewater Company
T.N.	Total Nitrogen
T.P.	Total Phosphorus
TSS	Total Suspended Solid
UNDP	United Nations Development Program
US	United States
USEPA	United States Environmental Protection Agency

1. Introduction

1.1 Background

Effective management is derived from well-considered monitoring and evaluation systems[1]. Monitoring is to observe a situation for any changes which may occur over time. The adequate monitoring and evaluation makes the basis for improved decision making. Adaptive management, which is the overall goal of the Anzali Wetland Ecological management Project (hereinafter called the Project), is an iterative process that involves the integration of management plan, monitoring and evaluation to systematically examine the management to adapt and learn. The goal of the adaptive management is to adapt and learn to improve management[2].

DOE Guilan and relevant organizations have carried out monitoring and the results have been used for the decision making such as number of hunting licenses, control of protected areas, and other conservation measures. However the monitoring has been conducted irregularly and decisions have been made separately from monitoring results.

Anzali wetland is comprised of physical and biological characters, and in order to evaluate the condition of the wetland and make appropriate decisions, necessary items must be monitored regularly and analyzed synthetically. Understanding of the wetland ecosystem is crucial for the wetland management

The manual contains various items related to the wetland and is written from sampling to recommendation method. It is necessary to carry out the monitoring for wetland management by the relevant organizations.

1.2 Scope of the manual

The intended aim of this monitoring manual is to establish the proper monitoring system for the Anzali wetland management. The manual explains the activities to proceed with adaptive management, and, in particular, focuses on the quality control and data handling. Adaptive management requires the reliable data and logical evaluation for decision making. This manual will be used by the experts to proceed with adaptive management.

1.3 Assignment of tasks for the implementation of monitoring

Monitoring plans are examined by the data handling unit[3] and determined by the Anzali wetland management committee. Subsequently, monitoring activities will be allocated to DOE Guilan and relevant organizations. The expected tasks and organizations for the

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[1] Woodhill, J. 2000. Planning, monitoring and evaluating program and projects: introduction to key concepts, approaches and terms. World Conservation Union.

[2] Stem, C, et al. 2005. Monitoring and evaluation in conservation: a review of trends and approaches. Conservation Biology, 19-2: 295-309.

[3] Data handling unit will be formulated under the Anzali Wetland Management Committee.

implementation of monitoring are shown in Table 1.1. The flow of the monitoring and feedback is delineated in Figure 1.1.

Table 1.1 Tasks and Implementing Organizations

Monitoring	Implementing Organization
Monitoring plan	Data handling unit
Birds monitoring	DOE Guilan
Fish monitoring	Shirat and National inland water aquaculture institute
Plants monitoring	National inland water aquaculture institute
Plankton and benthos monitoring	National inland water aquaculture institute
Water and sediment quality monitoring	DOE Guilan
Water level monitoring	DOE Guilan and PMO
Economical monitoring	MOJA, GCHHTO, PMO, Silat, and DOE Gilan
Database, evaluation and reporting	Data handling unit
Review of monitoring	Data handling unit

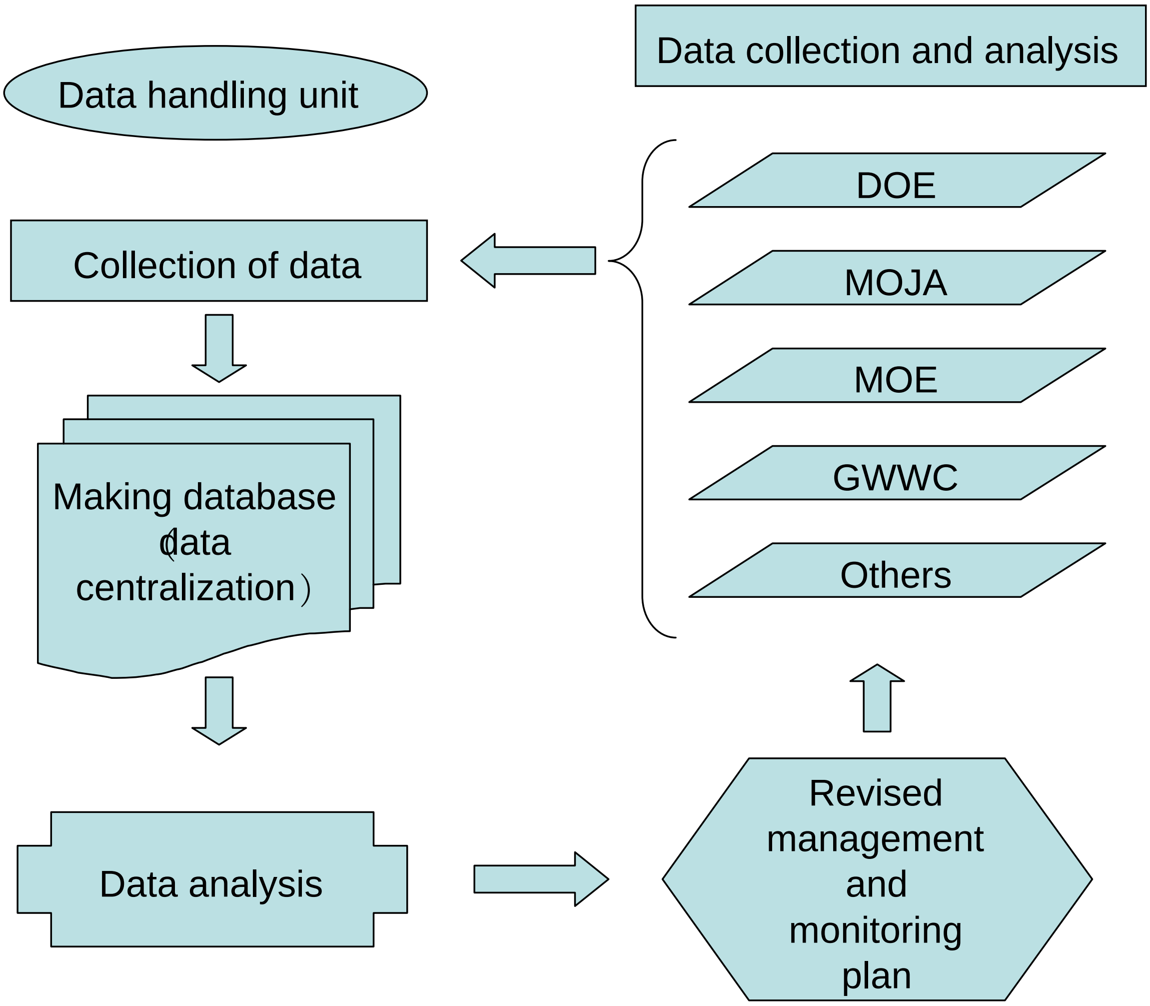


Figure 1.1 Flow of Monitoring and Feedback

1.4 How to use the monitoring manual

This monitoring manual will be approved by the Anzali wetland management committee. The manual will be used by DOE Guilan and the relevant organizations on which tasks are assigned. The monitoring methods have been prepared using present standards and regular monitoring methods. However some monitoring methods and stations (survey areas) have been revised to carry out the integrated data analysis. Therefore, the assigned organizations must follow the methods of this monitoring manual. Data handling unit will also need to follow the manual, but the unit needs to review the methods for sampling, analysis and evaluation. Hence, the data handling unit will follow this manual first, and will examine and modify the manual. The assigned organizations should follow the modified version of the monitoring manual.

2. Overview of the Monitoring Manual

The manual does not only include sampling and analysis methods, but also related activities such as quality control, data handlings, reporting and feedback of the evaluation to the methods of monitoring, in order to achieve the adaptive management of the Anzali wetland. Chapter 3 shows the indicators of wetland condition and the process of selection. Chapter 4 is quality control and quality assurance. Chapter 5 explains data handling and reporting. The database plan and some data analysis methods are introduced. Reporting is also described to make an effective report for the decision making of the wetland management. How to revise the monitoring is mentioned in Chapter 6. Sampling and analysis methods are explained in Chapter 7 for all items that include indicators. Training needs for the activities using this manual are written in Chapter 8. Chapter 9 shows the necessary budget of the monitoring.

Chapter 3: Indicators of wetland condition

Chapter 4: Quality Control and Quality Assurance

Chapter 5: Data Handling and Reporting

Chapter 6: Review of Present Sampling and Analysis

Chapter 7: Sampling and Analysis Methods

Chapter 8: Training Needs

Chapter 9: Necessary Budget of Monitoring

3. Indicators of wetland condition

3.1 What indicators are

Indicators are the items that indicate the wetland condition positively or negatively. In the wetland, indicators can be selected from biological, chemical, physical and economic aspects. The items must be monitored periodically, and the result needs to be used for decision making. There are many items that are related to the wetland condition, but it is difficult to conduct the monitoring for the all items, and the substantial amount of information would cause confusion in understanding the complicated wetland ecosystem. Therefore the number of indicators should be limited. On the other hand, as the limited indicators might miss some aspects of wetland degradation, periodical review of the indicators is also necessary.

3.2 Selection of indicators

3.2.1 Selection with criteria

Indicators are categorized into four groups i.e. biological, chemical, physical and economic, and the criteria to select adequate indicators are different among these groups. The groups and their selection criteria are shown below (Candidate indicators and their match with criteria are shown in Attachment 1.).

(1) Biological indicators

a. Amount of population,
b. Hunting and fishing interest,
c. Rareness in the country and in the world, and
d. Availability of data

(2) Chemical indicators

a. Present values compared to the standard values,
b. Magnitude of the impact on the wetland ecosystem and human life,
c. Correlation with the other indicator items, and
d. Availability of data

(3) Physical indicators

a. Magnitude of the impact on the wetland ecosystem and human life,
b. Correlation with the other indicator items, and
c. Availability of data

(4) Economic indicators

a. Magnitude of the impact on the wetland ecosystem and human life,

b. Correlation with the other indicator items, and

c. Availability of data

3.2.2 Complementary analysis

Compilation with standard values was carried out, subsequently, numerical analyses were carried out to confirm and revise the indicators that were selected with the above criteria. The analyses used were principal component analysis and regression analysis. The method and sample analysis were shown in Attachment 1.

3.3 Selected indicators

Indicators to be monitored for the decision making of the Anzali wetland management were selected using the criteria and complementary data analysis discussed in 3.2. Most of the data of CN were under the minimum detection value in 2003, these items were therefore deleted from the initial indicators. On the other hand, number of genus for phytoplankton, zooplankton and benthos were added into the initial indicators. The selected indicators are shown in Table 3.5 with sampling frequency, monitoring location and responsible organization. The indicators and other related matters should be reviewed after the initial monitoring results will have been examined.

Table 3.1 Selected Indicators of Wetland Condition

Type	Indicator	Sampling frequency	Monitoring location	Implementing organization
Biological indicator				
Birds	Population and number of species	Seasonally	Selkeh, Sorkhankol, Siahkeshim, Hossein bekandeh, Estuary, East, West, Central	DOE Guilan
	Terns	Summer	Selkeh, Sorkhankol, Siahkeshim	DOE Guilan
	Dalmatian Pelican	Seasonally (except summer)	Selkeh, Sorkhankol, Siahkeshim, Hossein bekandeh, Estuary, East, West, Central	DOE Guilan
	Pygmy Cormorant	Seasonally	Selkeh, Sorkhankol, Siahkeshim, Hossein bekandeh, Estuary, East, West, Central	DOE Guilan
	Whooper Swan	Seasonally (except summer)	Selkeh, Sorkhankol, Siahkeshim, Hossein bekandeh, Estuary, East, West, Central	DOE Guilan
	Ferraginous	Seasonally (except	Selkeh, Sorkhankol, Siahkeshim, Hossein bekandeh, Estuary, East,	DOE Guilan

	Duck	summer)	West, Central	
	Common Coot	Seasonally (except summer)	Selkeh, Sorkhankol, Siahkeshim, Hossein bekandeh, Estuary, East, West, Central	DOE Guilan
	White Tailed Eagle	Seasonally	Sorkhankol, Siahkeshim, Espand,	DOE Guilan
Fish	Catch per unit effort	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
	Esox lucius	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
	Vimba vimba persa	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
	Cyprinus carpio	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
	Abramis brama	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
	Rutilus rutilus	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
	Rutilus frisii kutum	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
Macrophyte	*Azola*.sp (Area)	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
	Phragmites australis (Area)	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
	Trapa natans (Area)	Seasonally (except winter)	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central	Inland Water Aquaculture Institute
Phytoplankton	Biomass and genus (per litter)	Monthly	All water and sediment quality stations	Inland Water Aquaculture Institute
Zooplankton	Biomass and genus (per litter)	Monthly	All water and sediment quality stations	Inland Water Aquaculture Institute
Benthos	Biomass and genus (per	Monthly	All water and sediment quality stations	Inland Water Aquaculture

	m^2)			Institute
Chemical indicator				
Water and Sediment quality	pH (W)*	Monthly	All stations selected in chapter 7	DOE Guilan
	DO (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	E.C. (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	T.P. (W, S)	W:Monthly S:Annually (May)	All stations selected in chapter 7	DOE Guilan
	T.N. (W, S)	W:Monthly S:Annually	All stations selected in chapter 7	DOE Guilan
	BOD (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	COD (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	Chlorophyll a (W)	Seasonally	All stations selected in chapter 7	DOE Guilan
	Fecal coliforms (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	Pb (W, S)	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	Cd (W, S)	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	Cr6+	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	As (W, S)	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	Hg (W, S)	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	Ni (W, S)	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	Cu (W, S)	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	Fe (W, S)	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	Sulfide (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	Sulfate (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	EH (W)	Monthly	All stations selected in chapter 7	DOE Guilan

	TPH (W, S)	W:Seasonally S:Annally	All stations selected in chapter 7	DOE Guilan
	PAHs (S)	Annually	All stations selected in chapter 7	DOE Guilan
	Pesticides (W, S)	W:Seasonally S: Annually	All stations selected in chapter 7	DOE Guilan
	TDS (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	TOC (S)	Annually	All stations selected in chapter 7	DOE Guilan
Physical indicator				
Water and Sediment quality	Temperature (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	TSS (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	Water depth (W)	Monthly	All stations selected in chapter 7	DOE Guilan
	Particle size distribution (e.g., percent sand, silt and clay) (S)	Annually	All stations selected in chapter 7	DOE Guilan
Water volume	River flow rate (W)	Monthly	Rivers	DOE Guilan
Water level	Water level (W)	Monthly	All stations selected in chapter 7	DOE Guilan
Economic indicator				
Fishery	Fish catch	Annually	Selkeh, Sorkhankol, Siahkeshim, Estuary, East, West, Central, rivers	Shilat
Agriculture	Rice product	Annually	Anzali, Somehsara	MOJA
Hunting	Hunting amount	Annually	Selkeh, Sorkhankol, Siahkeshim, East, West, Central	DOE Guilan
Tourism	Tourists to the wetland	Seasonally	Selkeh, Siadarvisian, Estuary	GCHHTO

Note: PMO: Port and Marine Organization, MOJA: Ministry of Jihad-e-Agriculture, GCHHTO: Guilan Culture, History and Handicraft Tourism Organization, W: Water, S: Sediment

4. Quality Control and Quality Assurance[4]

4.1 Purpose and definition

The purpose is to ensure that data generated by physico-chemical and biological monitoring is reliable.

Quality Assurance (QA) is a documented system of operating guidelines that will produce reliable data during sample collection, transportation and analysis. Quality Control (QC) is an integral aspect of QA and focuses on ensuring that analytical data are both accurate and precise. The QC should encompass all techniques to be used to measure and assess data quality, determination of analytical performance criteria including limits of detection / practical reporting limits / measurement uncertainty, and remedial actions to be taken when quality criteria are not met.

4.2 Quality assurance plan

In preparing QA programs, laboratories are required to develop systems capable of meeting the requirements of the current version of ISO 17025 “General requirements for the competence of the testing and calibration laboratories”.

Laboratories are encouraged to seek accreditation for relevant parameters, and the following elements should be covered in QA/QC system:

- Sampling, sample transportation, receipt, storage and preservation
- Documented analytical procedures based on recognized standard
- In-house Quality Control procedures and participation in relevant external performance testing schemes
- Validation of test methods response, limits of detection, and measurement uncertainty
- Staff training and competency
- Reporting procedures, information storage and data security

Guidance on sampling procedures can be found in the following sources:

The use of Certified Reference Materials (CRMs) is encouraged where appropriate to the parameters monitored. These can prove useful in validating analytical performance.

[4] Reference for this chapter is “Ireland Water Framework Directive Monitoring Programme, 2006. Environmental Protection Agency, Ireland.

4.3 Analytical performance requirements

The choice of analytical methods available is extensive. It is acknowledged that laboratory facilities will generally utilize in-house documented procedures.

As minimum analytical procedures used should be capable of achieving deviation of less than 10% of the concentration of interest, or the lowest measurable value that can be reported with a known statistical confidence. A total error threshold of ± 20% is considered to be the maximum allowable and would be assigned equally to bias and random variation.

Specific performance criteria and prescription of required analytical approaches may require to be defined for some parameters to ensure data comparability.

4.4 Guidance on reporting and interpretation of data

4.4.1 Rounding

It is common practice to round instrument measured values. Consideration must be given to rounding such data in a manner that does not diminish its usefulness for evaluation. In general, rounding should provide a result where the uncertainty exists only in the last significant figure. Where summed values are reported, these should be reported to the significance figures applied to the least accurate measurement. The use of 3 significant figures is generally sufficient for most analytical work.

4.4.2 Limit of detection and reporting of low concentrations

The limit of detection of an analytical system can be defined as the lowest concentration for which a response is measurable above background noise with a defined (typically 95%) statistical confidence. It is desirable that the limit of detection is based on an examination of a series of batches of analyses over time by different analysts, and not only on the evaluation of the best possible performance or lowest detectable signal alone within a single batch of analyses.

While the limit of detection provides a measure of the lowest signal detectable at the defined confidence level, it is common for laboratories to apply a somewhat higher value as a practical reporting limit or lower limit of quantification. This is generally a multiple of the limit of detection and is used as an additional safeguard to ensure that responses to the detection of substances at low concentrations are merited based on a higher confidence of its detection.

4.4.3 Reporting and Interpretation of Low Concentrations

A major difficulty with measurement at very low concentrations is that analytical systems can provide responses falling below the calculated limit of detection or lower limit of quantification.

Such data is often seen reported in one of the following ways:

- As Not detected (ND)
- As Less than the limit of detection
- As zero (0)
- As an arbitrary fraction of the limit of detection (e.g. limit of detection/2)
- As the measured value + its measurement uncertainty

The terms “Not Detected” and “Zero” should never be used they convey no quantitative or qualitative information and are wholly dependent on the characteristics of the measurement system used. In many samples it will not be possible to determine, with absolute confidence, the complete absence of a particular substance.

Reporting values as less than the limit of detection is the most commonly accepted practice. However incorporating such values into statistical calculations requires their transposition to a replacement value e.g. limit of detection/2. These values may facilitate calculations but the calculated statistic may be biased and should always be referenced back to the original limit of detection.

In all cases it is essential that a clear distinction is made between recorded values and any subsequently reported results.

4.4.4 Estimation and use of recovery factors

Quantitative results should be corrected for recovery unless there are specific reasons for not doing. It is important that all data should be clearly identified as to whether or not a recovery correction has been applied and if a recovery correction has been applied, the amount of the correction and the method by which it was derived should be included with the report.

Recovery values should be established as part of method validation. When the use of a recovery factor is justified, the method of its estimation should be specified in the method protocol.

QC charts for recovery should be established during method validation and used in all routine analysis. Runs giving recovery values outside the control range should be considered for re-analysis in the context of acceptable variation, or the results reported as semi-quantitative.

4.4.5 Plausibility checks

Data should be checked prior to reporting for overall plausibility and comparability with previous samples. The use of comparative ratios such as BOD:COD, Na:K, Ionic balances etc., is recommended. Plotting of trends in such ratios can be of assistance in the early detection of trends in natural variations or step changes due to analytical factors. This may be particularly relevant when assessing parameters which are naturally low e.g. trace metals concentrations. In addition, such checks may also serve to highlight differences in reporting units e.g. Nitrate as NO^3 or as N, Phosphate as P or as PO^4 etc. especially where data from a range of sources is being aggregated.

5. Data Handling and Reporting

5.1 Data handling

5.1.1 Database

A database is a collection of data that is stored in a computer and that can easily be used and added to. A database is necessary for the analysis of Anzali wetland condition and decision making for wetland management.

Various data must be centralized to analyze the wetland condition. The data handling unit under the secretariat of Anzali Wetland Management Committee will undertake to manage the data, and relevant organizations need to provide the necessary data for the reliable examination (Figure 5.1).

There are several types of database software. However, this manual recommends Microsoft Excel, taking the convenience of experts into consideration. Excel files have been prepared for making the database. Figure 5.2 shows a sample sheet for the database. Excel automatically calculates the annual average and draws the diagram to show the annual change. For water quality, input data is compared with the standard value, and a number of stations over the standard value are automatically calculated. Yearly change is also delineated in a diagram. The sheet is copied and the data for the next year will be entered in the cells. The data will be consistently accumulated in a file with this process.

This Excel file will be prepared by the project, and provided to the data handling unit.

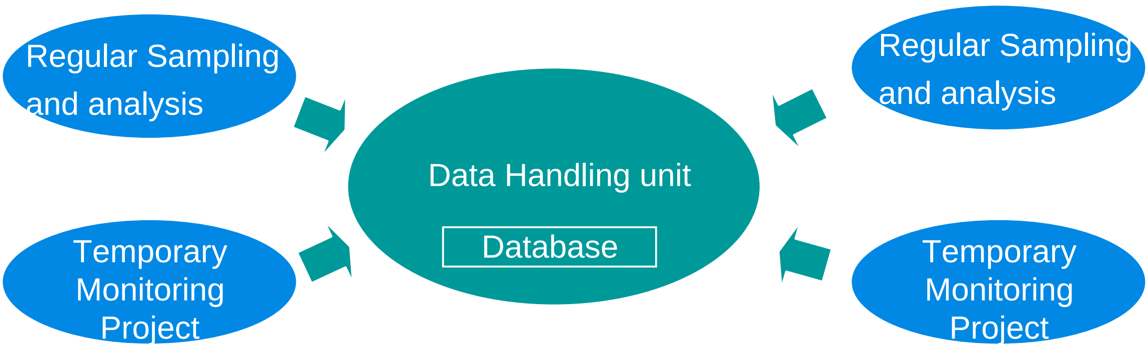
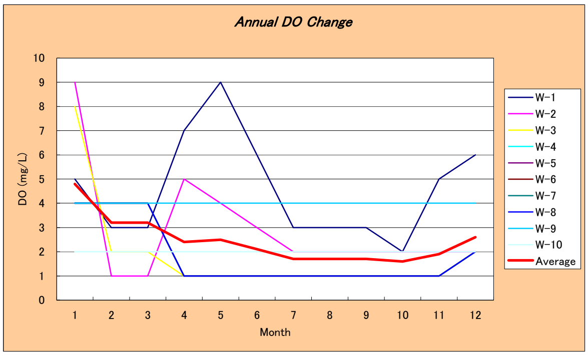


Figure 5.1 Centralization of Monitoring Data

DO (Unit: mg/L) (Standard: 5)

Annual data

Sampling Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	Max	Min	No. over standard
W-1	5.00	3.00	3.00	7.00	9.00	6.00	3.00	3.00	3.00	2.00	5.00	6.00	4.58	9.00	2.00	4
W-2	9.00	1.00	1.00	5.00	4.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00	2.92	9.00	1.00	1
W-3	8.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.83	8.00	1.00	1
W-4	4.00	4.00	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.83	4.00	1.00	0
W-5	4.00	4.00	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.83	4.00	1.00	0
W-6	4.00	4.00	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.83	4.00	1.00	0
W-7	4.00	4.00	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.83	4.00	1.00	0
W-8	4.00	4.00	4.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.83	4.00	1.00	0
W-9	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	0
W-10	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	0
Average	4.80	3.20	3.20	2.40	2.50	2.10	1.70	1.70	1.70	1.60	1.90	2.60	2.45	5.20	1.50	0.6



Years data

Sampling Station	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Average	Max	Min	No. over standard
W-1	4.25												4.25	4.25	4.25	11
W-2	2.33												2.33	2.33	2.33	11
W-3	1.50												1.50	1.50	1.50	11
W-4	1.83												1.83	1.83	1.83	11
W-5	1.83												1.83	1.83	1.83	11
W-6	1.83												1.83	1.83	1.83	11
W-7	1.83												1.83	1.83	1.83	11
W-8	1.83												1.83	1.83	1.83	11
W-9	4.00												4.00	4.00	4.00	11
W-10	2.00												2.00	2.00	2.00	11
Average	2.33	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	2.33	2.33	2.33	11

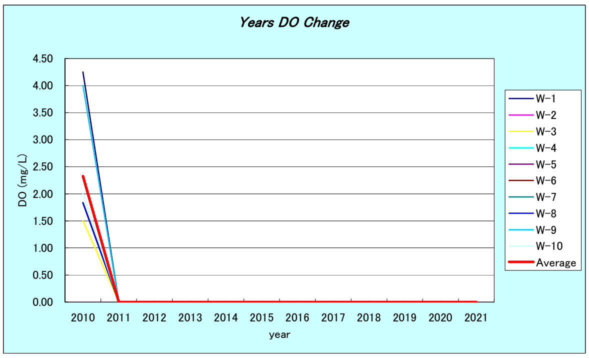


Figure 5.2 Sample of the sheet for database

5.1.2 Data analysis

Data analyses are carried out by the following processes.

- Comparison with standard value
- Observation of annual changes
- Observation of changes over years
- Examination and evaluation of the result

(1) Comparison with standard value

Collected data is primarily compared with standard values. If the data of an item exceeds the standard value, the magnitude and frequency among sampling stations are examined.

(2) Observation of annual changes

Annual change of the items must be confirmed to know the fluctuation of data. For water quality, depending on the source of pollution load and/or characteristics of parameters, the annual changes are different. Conversely, characteristics of the source of pollution load can be examined with the annual change of parameters.

The annual changes of other items such as birds, fish and plankton must be confirmed to know their living characteristics in a year.

(3) Observation of changes over years

Yearly changes of the water quality parameter exceeding the standard value must be reviewed in order to find out if the annual value is a sample analysis error or not. If it is correct and permanent, the cause should be examined. As for birds, fish macrophyte, plankton and benthos, with water quality and water level, it is possible to reveal the habitat condition and impacts among these.

(4) Examination and evaluation of the result

The obtained data must be examined individually and comprehensively. Individual examinations are initially carried out as written above. Then comprehensive examinations are carried out. In this manual, principal component analysis (PCA) and regression analysis are introduced. These were used to select environmental indicators (refer to Attachment 1). PCA can imply the structure and mechanism of wetland ecosystem with showing the group of items as principal components. Regression analysis can explain the relation of items in the principal components. For example, if we find the loss of threatened fish and change of ichthyofauna, we can do PCA. Fish item should be found in one principal component, and then regression analysis should be carried out among items in the principal component. The cause of the problem may be estimated with the data as it is by industrial discharge, agricultural chemical use, domestic discharge, etc. Those relevant data must be available from relevant organizations such as MOJA, GWWC and GRWO.

The macro for PCA calculation is prepared by the project and provided to the data handling unit. Regression analysis can be carried out with the tool function of Excel. Sample explanations of PCA and regression analysis are written in Attachment 1.

5.2 Reporting

The analyzed data must be used for decision making on Anzali wetland management. In order for the Anzali wetland management committee members to make decisions, the data handling unit needs to describe the issues and evaluation, and propose the measures that should be taken. Those are expressed in a report concisely, clearly and easily. A sample report is attached to this manual (see attachment 2). The contents of the report are summarized below.

(1) Monitoring result

Monitoring result is described using the data analysis described above (Section 5.1.2). The text should be the minimum needed to understand the present condition and the issues of concern (Raw data is attached on the report). Tables and figures should be used with minimum explanations. Any serious problems should be highlighted and the priority of the issues should be made clear. Priority is determined by criteria such as effect, urgency, efficiency, maturity, capacity of executing organization and cost.

(2) Necessary measures

The measures, including alternatives for each issue should be described concisely. The expected responsible organization, target, deadline and procedure should be defined. A detailed program should be attached to the report.

6. Review of Present Sampling and Analysis

Monitoring results must be reviewed periodically. The present manual has been prepared with available data that is almost all from the Master Plan study. However, for example, indicators are just the first hypothesis. The indicators, frequency and methods of monitoring should be revised as the monitoring data is accumulated. If we do not use the monitoring method that meets to the purpose of the monitoring, the effect would be low.

Monitoring result should be reviewed in advance of each year's budget. The data handling unit needs to prepare a proposal for revised monitoring and submit it to the AWMC. AWMC will have a meeting to discuss the budget allocation for the activities related to wetland management. The proposal will be discussed in the meeting of AWMC, prior to approval. The necessary budget will then be requested to the central government.

The process is described in Figure 6.1.

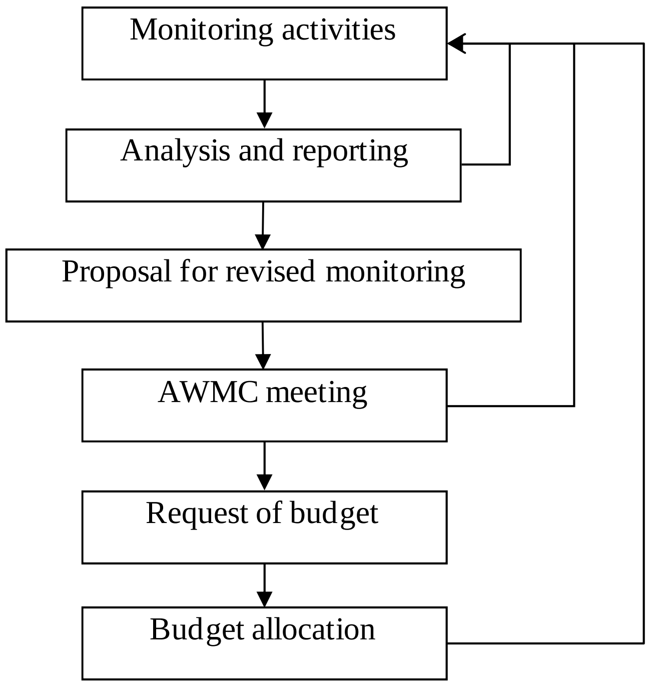


Figure 6.1 Review of Monitoring

7. Sampling and Analysis Methods

7.1 Setting of methodology

Monitoring methods were set by the monitoring group of the project in association with NIWAI. The methods are derived from present monitoring activities taking present capacity and instruments of relevant organizations into consideration. Water quality monitoring methods referred to the standard methods of USEPA that DOE laboratory is following.

7.2 Site selection and frequency

Sampling stations and frequency were selected to reveal the ecological condition of Anzali wetland. Taking practicability into consideration, minimum and necessary stations were selected. The stations are shown in Figure 7.1, and frequency and implementing organization is shown in Table 7.1.

Sampling sites were allocated on the whole wetland for biological and phisico-chemical indicators. Sampling stations were allocated on the rivers flowing into the wetland for plankton, benthos, water and sediment quality indicators. The coordinates (UPM/UPS) of sampling stations are shown in Table 7.2.

Sampling frequency was selected basically seasonally in biological indicators, monthly in phisico-chemical indicators of water and annually in sediment as well as economical indicators. The exact period must be changed by the season of each indicator (e.g. migratory season).

Table 7.1 Sampling Frequency

Type of Indicators	Sampling Frequency	Organization
Birds	Winter (waterfowl), spring (terns)	DOE Guilan
Fish	Seasonally (except for winter)	NIWAI
Macrophyte	Seasonally (except for winter)	NIWAI
Phytoplankton	Monthly	NIWAI
Zooplankton	Monthly	NIWAI
Benthos	Monthly	NIWAI
Water quality	Monthly	DOE Guilan
Sediment quality	Annually or seasonally	DOE Guilan
Water level	Monthly	DOE Guilan and PMO
Fishery	Annually	Shilat
Agriculture	Annually	MOJA
Hunting	Annually	DOE Guilan
Tourism	Seasonally	GCHHTO

Note NIWAI: National Inland Water Aquaculture Institute, PMO: Prot and Marine Organization, MOJA: Ministry of Jihad-e-Agriculture, GCHHTO: Guilan Culture, History and Handicraft Tourism Organization

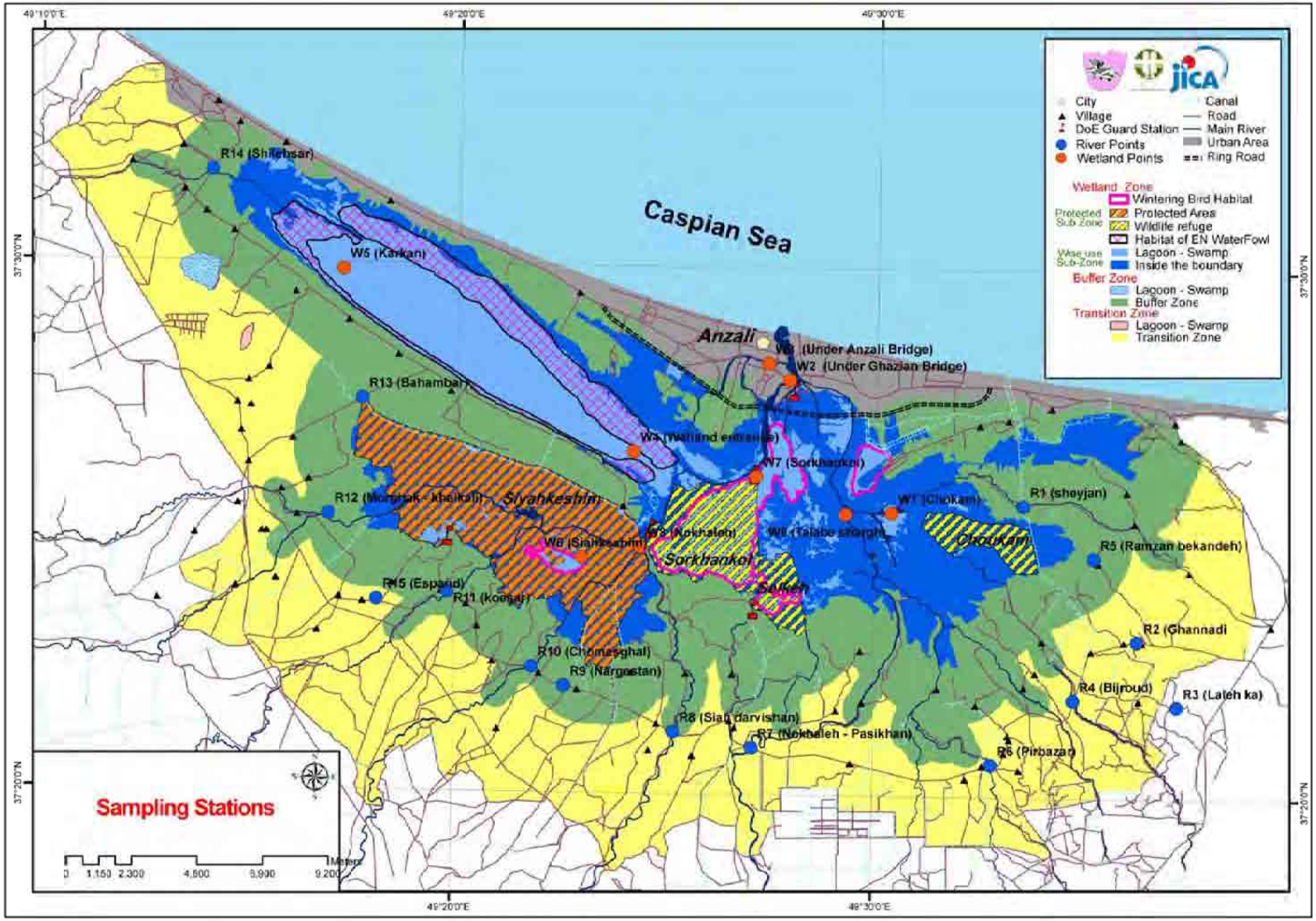


Figure 7.1 Sampling Stations of Monitoring

Table 7.2 Coordinates of Sampling Stations

Name	No*	X	y
Chokam	W1	367839	4142861
Under Ghazian Bridge	W2	364548	4147588
Under Anzali Bridge	W3	363801	4148176
Wetland Entrance	W4	358783	4145045
Karkan	W5	348617	4151504
Siahkeshim	W6	356943	4141341
Sorkhankol	W7	363079	4144154
Nokhaleh	W8	359009	4141829
Talabe Shargh	W9	366225	4142826
Sheyjan	R1	372471	4143082
Ghannadi	R2	376441	4138294
Laleh ka	R3	377832	4136004
Bijroud	R4	374186	4136246
Ramzan bekandeh	R5	374935	4141224
Pirbazar	R6	371288	4134005
Nokhaleh (Pasikhan)	R7	362895	4134642
Siah darvishan	R8	360141	4135210
Nargestan	R9	356295	4136841
Chomesghal	R10	355174	4137515
koesar	R11	352213	4140167
Morghak (khalkaii)	R12	348051	4142930
Bahambar	R13	349260	4146966
Shilehsar	R14	344026	4155009
Espand	R15	349718	4139918

7.3 Birds

7.3.1 Survey period

Avifauna is surveyed in two seasons. Breeding birds are surveyed from May to June at adequate time.

7.3.2 Survey organization

DOE Guilan

7.3.3 Survey method

(1) Avifauna

Bird recognition in the field is conducted based on form of flying, body size, apparent shape, wing and feather color, behavior and specific sound or song by using different field guidance. In order to recognize the birds and evaluate the population of birds at Anzali wetland, engine boats are used. In some cases such as Selkeh, the survey is conducted on foot and from bird watching tower by using binoculars, monocular telescope and camera. Birds survey is conducted by using total count. International wetlands organization proposes this method for counting the birds in wetland area[5]. The coordinates (UPM/UPS) of survey points are shown in Table 7.3.

Table 7.3 Coodinates of Survey Points

Station Name	Station Number	X	Y
Central Wetland	1	3726839	4927548
Wetland West	2	3729022	4919771
Wetland East	3	3725934	4929759
Selkeh	4	3723654	4927509
Sorkhankol	5	3725077	4926383
Siahkeshim	6	3724850	4922495
Espand	7	3724947	4919810
Hosein bekandeh	8	3726082	4929412
Chokam	9	3724573	4932619
Marghob Abbandan	10	3729945	4913869

(2) Breeding birds

In order to recognize and evaluate the population of breeding birds, census survey is conducted. The nests of each bird are also counted. For some species such as Whiskered tern which breed in the wetland in high extent, direct counting method is used. For some areas such as Selkeh and Siahkeshim, breeding birds are counted. An area is divided into blocks, and the number of blocks is counted. The number of breeding birds in some

[5] Torres, R. (1995). Waterfowl Community Structure of Languna Sento Domingo during an annual cycle, Rev. Asoc. Sci. Nat. Litor. St. Tome, 26: 33-40.

blocks is counted and the average is multiplied by the number of blocks.

7.3.4 Creation of database

In the Excel sheet, location, date, time, weather, name of surveyor, birds data and remarks are typed.

7.4 Fish

7.4.1 Survey period

Fish is surveyed in three seasons from spring to autumn.

7.4.2 Survey organization

National Inland Water Aquaculture Institute and DOE Guilan

7.4.3 Survey method

Fish species are collected by both active (electro fishing: once, and cast net: 10 times) and passive (gill net: once, and purse seine net: once) methods. As soon as fish are caught, their common names are recorded by experienced experts, and the number of each species is also recorded to count the catch per unit effort. The fish are carried alive to laboratory and precise weight and length are measured.

7.4.4 Creation of database

In the Excel sheet, location, date, time, weather, name of surveyor, fish data and remarks are typed.

7.5 Macrophyte

7.5.1 Survey period

Macrophyte is surveyed in three seasons from spring to autumn.

7.5.2 Survey organization

National Inland Water Aquaculture Institute and DOE Guilan

7.5.3 Survey method

Areas of three indicator species are roughly measured per ha. Vegetation structure is also surveyed. A quadrat is established at each sampling station. Name of species and its coverage (%) for all macrophyte at the quadrat are recorded.

7.5.4 Creation of database

In the Excel sheet, location, date, time, weather, name of surveyor, macrophyte data and remarks are typed.

7.6 Phytoplankton

7.6.1 Survey period

Phytoplankton is surveyed in three seasons from spring to autumn.

7.6.2 Survey organization

National Inaland Water Aquaculture Institute and DOE Guilan

7.6.3 Survey method

Phytoplankton sample is collected by P.V.C tube. It placed in a vertical direction within particular water depths, and then the sampled water transferred into bucket and finally one litter liquid is collected and fixed with formalin. Phytoplankton in the fixed water is identified and counted using microscope. The number of individuals is also recorded.

7.6.4 Creation of database

In the Excel sheet, location, date, time weather, sampling depth, name of surveyor, phytoplankton data and remarks are typed.

7.7 Zooplankton

7.7.1 Survey period

Zooplankton is surveyed in three seasons from spring to autumn.

7.7.2 Survey organization

National Inaland Water Aquaculture Institute and DOE Guilan

7.7.3 Survey method

In the Anzali wetland at 12 stations, zooplankton sample is collected by P.V.C tube. Thirty litters of water are collected and subsequently screened by 30 μm plankton net. The collected sample is poured in sampling jar. The sample is fixed with 4% formalin to preserve zooplankton. In rivers at 11 stations, directly 30 litters of water are screened with plankton net, mesh size 30 μm, the collected sample is poured in sampling jar. The sample is fixed with 4% formalin. The sample transferred to the laboratory is identified with microscope to possible taxonomic family or genus. The number of individuals is also recorded.

7.7.4 Creation of database

In the Excel sheet, location, date, time weather, sampling depth, name of surveyor, zooplankton data and remarks are typed.

7.8 Benthos

7.8.1 Survey period

Benthos is surveyed in four seasons.

7.8.2 Survey organization

National Inaland Water Aquaculture Institute and DOE Guilan

7.8.3 Sampling and sample analysis method

In the Anzali wetland at 12 stations, the 3 samples are collected by a bottom sampler (grab or Ekman dredge 20*20 cm^2) at each station. Sampling at 11 river stations is carried out using a Sorber sampler (40*40 cm^2) and 3 samples are collected at each station. The equipment is horizontally placed on the cobble substrate and benthic animals are put into the sampler net (500 μ m mesh) with washing and dislodging.

The collected materials which contain benthic animals are put into 1 liter jars and laveled at the sampling site. The samples are preserved with 4% formalin and are carried to the laboratory.

In laboratory, the collected sample is identified with stereo microscope to possible taxonomic family or genus. The biomass of the benthic animals is measured as dry and wet weight.

7.8.4 Creation of database

In the Excel sheet, location, date, time weather, name of surveyor, benthos data and remarks are typed.

7.9 Water quality

7.9.1 Survey period

Water quality is surveyed every month whole year.

7.9.2 Survey organization

DOE Guilan

7.9.3 Sampling and sample analysis method

(1) Temperature

Air and water temperature is measured with a thermometer at field. Temperatures are described as Celsius.

(2) TSS

First wait till the temperature reaches 105℃, and then put the filter paper in the oven (usually for 20 – 25 minutes). The filter paper is put in the desiccators for 20 – 30 minutes to become cool, and then weight it to get the primary weight. 100 ml or 50 ml of the non-acidic sample is poured in a mezor and the filter paper is also put in the funnel and put on the Erlenmeyer flask. The sample is passed through the filter paper and then the filter paper is taken and put in the Oven for 1 hour, then in the desiccators to be cool. It is weighted to get the secondary weight. The secondary weight is subtracted by the primary weight and multiplied by 10,000 and TSS is given.

(3) Water depth

Water depth is measured with a weight and a measuring tape at field.

(4) pH

It is measured by pH meter. Before reading the sample, pH meter is calibrated with 2 solutions, pH 4 and pH 7.

(5) DO

The sample is taken and fixed with $MnSO_4$ and KI. After deposition, 2 ml dense sulfuric acid is added and stirred well, and 100 ml is taken slowly not to make bulb. And it is poured into the beaker, and 1 – 1.5 ml starch is added and stirred a little till the solution becomes blue. Sodium tiosulfate is added by the burette so that it loses its color. The number on the apparatus is read and recorded. The number is multiplied by 2, and it is the value of DO.

(6) E.C.

EC is measured with potable EC meter (potansiometer: METROHM. WTW) at 20℃. The unit is Micro mouse/Cm.

(7) T.P.

100 ml of the filtered sample in Erlenmeyer flask and 15 ml of $K_2S_2O_8$ solution (peroxide potassium sulfate) is added to each one. And then 1 ml of dense sulfuric acid is added for 1.5 hour and heat at 100℃. The volumes of the samples are kept stable between 25 and 50 ml by distilled water during volume reduction. After cooling, a few drops of phenyl phthalein is added to it and neutralized by sodium hydroxide solution and then the volume reaches to 50 ml. And 8 ml agent is added to each. The concentration is measured by the spectrophotometer at 880 nm wavelength. The gained number is divided into two.

(8) T.N.

Wash the Teflon or plastic reaction dishes 4 or 5 times by 6NHCL and DDW. Pour 40 ml of the sample in the plastic or Teflon bottle, add 6 ml of the oxidizer solution. Autoclave the bottle with loose cap for 30 minutes at 121℃ (15 – 20 psi). Cool the samples.

Calibrate the 1.4M chloridric acid by calibration acid. Titre the blanks by HCL 1.4M to pH = 2.6 – 3.2. Dilute an appropriate 1.4M HCL so that 6.0 ml of it has pH = 2.6 – 3.2.

Add exactly 6.0 ml of the calibrated HCL solution to the samples to solve any sediment and reduce the pH. Transfer the solution to the 125 ml Erlenmeyer quantitatively. Add 3.0 ml buffer solution to the Erlenmeyer.

Determine the existing nitrate in the sample by using cadmium restoration method.

The above process is conducted for the sample and distilled water

A = milligram NO_3^- -N/L in the digested sample

B = milligram NO_3^- -N/L in the reagent blank

TN, mg N/L = 1.32(A-B)

(9) BOD

Measuring natural water with low BOD: 428 ml of the sample is poured into the special glass. The cover of the glass is put and 2/3 of caustic soda is added. And then the glass is incubated with 20℃for 10 – 15 minutes and attach it to the manometric apparatus that is a dark glass with a capacity of 500 ml. The manometric degrees are read as one unit. The degrees are recorded every day and it continues for 5 days.

High BOD: 157 ml of the sample is poured. The rest of the process is same above.

(10) COD

2 ml of the sample is poured into the special glass. 0.04 g mercury sulfate and 1.5 ml of potassium bichromate are added. It is boiled for 2 hours in the apparatus, and then after cooling, the number on the apparatus is read.

(11) Chlorophyll a

Water samples taken for plankton survey are filtered through 0.45μm GF/C filter papers in known volumes. Each filter paper with the retentate (i.e. the material retained on the paper after filtration) is stored in a plastic tube with preservative, covered in aluminium foil to prevent light entering, and transported on ice to the laboratory. The amount of chlorophyll-a in the retentate is determined using a spectrophotometer and the concentration of chlorophyll-a in the original sample calculated in g/m^3.

(12) Fecal coliforms

The experiment is done after the probable positive reaction in which the bacteria grown in the pipes of lactose broth are cultured in another medium called EC broth which is more selective than lactose broth.

In the process, a loop from every medium pipe of positive lactose broth comes into the

EC broth medium pipes. The pipes are put in the temperature of 44 degrees, because only the coliforms with excrement origin are able to survive this temperature; lack of gas production in the derham pipe indicates a negative reaction.

The pipes are put in the incubator for 24 hours; the existence of gas in the derham pipe and opacity of the environment shows the positive reaction of the confirmation of the process. The number of coliforms in 100 ml is gained by the use of the MPN table.

(13) Heavy metals (Pb, Cd, Cr6+, As, Hg, Ni, Cu and Fe)

Seven indicator heavy metals (Pb, Cd, Cr6+, As, Ni, Cu and Fe) are measured by the flame method. The measured value is in ppm precision. The gases used in this method are air and acetylene. The instrument is atomic absorption Spectrometer (Thermo S Series AA system). The saturated steam method is used for Hg.

(14) Sulfide:

A determined amount of Ayodin is poured in Flask 50 cc. Then the volume will be decreased to 20 cc in two stages and 2 cc Chloride Acid 2 mol. are added. Then using a pipette, 200 ml of the sample stabilized by Zinc Acetate is added to the liquid in the flask, adding a few starch drops and is titerated by tio sulfate.

(15) Sulfate:

50 cc of the sample is poured in Mayer Erlen 250 mm. Then 50 cc distilled water (H_2O_2) is added. 5 cc Sulfate quantifier and 0.2 g. Chlorobarium is added and stirred for 1 min. using magnetic mixture. After that the given solution is poured in spectrophotometer cell and light ray passing through it is detected in 420 nm and concentration is measured on Calibration curve.

(16) TPH:

Water samples are measured through liquid extraction -liquid and sediment sample by solid extraction- the liquid is extracted with Hexane solvent and then the sample is measured by spectro-floro-photometer.

(17) Eh:

Eh is extracted using Portable Multiparameter.

(18) Pesticides:

First, the samples are extracted, then Chlorinated pesticides are measured by GC device and TSD detector and Phosphated pesticides are measured using GC device and NPD detector.

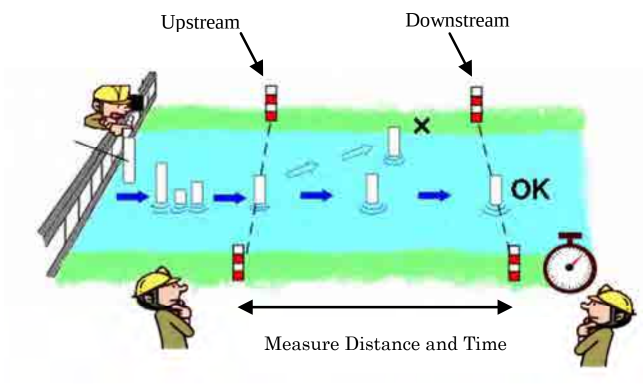
(19) TDS:

TDS is extracted by portable multi-parameter.

(20) River Flow Rate

Though the measurement is usually conducted using instruments, it is difficult to obtain those. For the time being, it is suggested to measure the river water volume with a simple method using floating material described below.

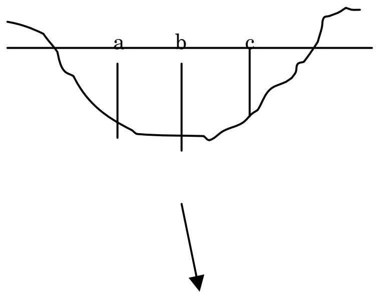
<Velocity>



The velocity of river water is measured as follows

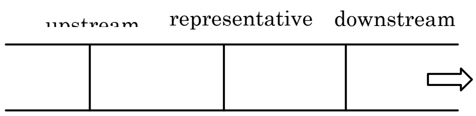
Velocity = Distance between Upstream and Downstream (m) / Floating Time from Upstream to

<Depth>



Depths are measured at three points at the representative section of each sampling point as follows

<Width>



Widths are measured at three points at each sampling point as follows
Width= Representative section (m)

River Water Volume (m^3/s) = Velocity (m/s) * Depth (m) * Width (m)

7.9.4 Creation of database

In the Excel sheet, location, date, time weather, name of surveyor, water quality data and remarks are typed.

7.10 Sediment Quality

7.10.1 Survey Period

Sediment Quality is surveyed once per year.

7.10.2 Survey Organization

DOE Guilan.

7.10.3 Sampling and Sample Analysis Method

(1) Sampling:

Sediment samples should be taken by grab samplers. Ponar, Van Veen or Ekman grab samplers may be used for sampling of surface bottom sediment.

(2) Total Phosphorous (TP):

Sediment samples for TP analysis first is sieved to particle sizing less than 2 mm. TP content is determined by combusting one gram of soil at 550°C in a muffle furnace for four hours. Ash is then dissolved in 6 *M* HCl (Andersen, 1976) and the digestate is analysed for TP using a modified ascorbic acid method (John, 1970).

(3) Total Nitrogen (TN):

To determine TN, one gram of soil is digested on a Kjeldahl block digester with one kjeltab, 15 ml of concentrated H_2SO_4, and 3 ml of 100 volumes hydrogen peroxide. Digestion times are one hour at 150°C and one half hour at 39°C. Digestate is analysed colorimetrically at 650 nm following Berthelot reduction using the salicylate method (Houba et al., 1987).

(4) Sediment Samples Preparation for Metals Analyses:

Sediment samples should be wet sieved through sieve mesh 230 to gain particles smaller than 63 µm. Sieved samples is dried in room temperature or in an oven (<40 °C) to constant weight. Dried sample then is grounded and 1 g of grounded sample is digested according to U.S.EPA 3050B method (Using HCl, HNO_3 and H_2O_2). Alternatively it can be digested by method of vigorous acids (HNO_3, HCl, $HClO_4$).

(5) Metals (Pb, Cd, As, Hg, Ni, Cr6+, Cu and Fe) Measurement:

Six indicator heavy metals (Pb, Cd, As, Ni, Cr6+, Cu and Fe) are measured by the flame method according to U.S.EPA methods 7000s series. The measured value is in ppm precision. The gases used in this method are air and acetylene. The instrument is atomic absorption Spectrometer (Thermo S Series AA system). The saturated steam method is used for Hg determination.

(6) TOC:

The total organic carbon (TOC) content of sediment is a measure of the total amount of oxidizable organic material. TOC is the sum of dissolved organic carbon (DOC), particulate organic carbon (POC) or suspended organic carbon (SOC), and colloids. TOC is an important parameter to measure in sediments because it is a major determinant of nonionic organic chemical bioavailability (DiToro et al., 1991). Metal bioavailability is also affected by the amount of TOC present in sediments. TOC is usually expressed as a percentage of the bulk sediment and is used to normalize the dry-weight sediment concentration of a chemical to the organic carbon content of the sediment. The organic carbon content of sediments has been measured using several methods including: wet oxidation titration, modified titration, and combustion after removal of carbonate by the addition of HCl and subsequent drying. USEPA methods (1986b), including SW-846 and 430/9-86-004, are often used to measure TOC. one of two methods is recommended to separate organic from inorganic carbon before analyzing for TOC: (a) ignition and using HCl as the acid for pre-treating sediment, or (b) differential combustion, which uses thermal combustion to separate the two forms of carbon. EPA guidance (1998) recommends that TOC analyses be based on high-temperature combustion rather than on chemical oxidation, because some classes of organic compounds are not fully degraded by combined chemical and ultraviolet oxidation techniques. So, TOC should be analyzed using any of the methods described in" METHODS FOR THE DETERMINATION OF TOTAL ORGANIC CARBON (TOC) IN SOILS AND SEDIMENTS" by U.S.EPA (2002).

(7) TPH:

Sediment samples are prepared for TPH analysis according to U.S.EPA method number 3540C in order to extract organics from solid media. After extraction the procedure for determination of TPH in sample is the same as the one for water samples.

(8) PAHs:

Sediment samples are prepared for TPH analysis according to U.S.EPA methods number 3540C or 3550b in order to extract organics from solid media. Content of PAHs in extracted sample then is determined according to U.S.EPA method number 8100. This method is based on determination by GC/FID for the detection of ppb levels.

(9) Pesticides:

Sediment samples are prepared for analysis according to soxhlet extraction method U.S.EPA 3540C. Soxhlet® extraction involves distillation with a solvent such as acetone, dichloromethane/methanol (2:1), dichloromethane/methanol (9:1), and benzene/methanol (3:2). USEPA (1983) recommends sonication with solvent mixtures and a 30-gram subsample of sediment. Drying the extract can be accomplished through separatory funnel partitioning as needed to remove water and sodium sulfate or by using a Kuderna-Danish apparatus and rotary evaporation with purified nitrogen gas for concentration to smaller volumes. Using the separatory funnel partitioning method, the wet sample is mixed with methanol and centrifuged. The supernatant is decanted and extracted later. Extraction of the sample is continued using less polar solvents and the water/methanol and solvent extracts are combined and dried. Analysis is performed using GC/ECD or GC/MS instruments. Different methods of the analysis of pesticides in prepared samples for various pesticides are described in U.S.EPA report 821/R-93-010-A which should be followed.

(10) Particle Size Distribution:
Particle size is used to characterize the physical characteristics of sediments. Because particle size influences both chemical and biological characteristics, it can be used to normalize chemical concentrations and account for some of the variability found in biological assemblages or in laboratory toxicity testing. Particle size can be characterized in varying detail. The broadest divisions that generally are considered useful for characterizing particle size distributions are percentages of gravel, sand, silt, and clay. However, each of these size fractions can be subdivided further so that additional characteristics of the size distribution are determined. Particle size determinations can either include or exclude organic material. If organic material is removed prior to analysis, the “true” (i.e., primarily inorganic) particle size distribution is determined. If organic material is included in the analysis, the “apparent” (i.e., organic plus inorganic) particle size distribution is determined. Because true and apparent distributions may differ, detailed comparisons between samples analyzed by these different methods are questionable. Therefore, if comparisons among samples between studies is desired, sediment particle size should be measured using consistent methods. Sediment particle size can be measured by a number of different methods. The best method will depend on the particle properties of the sample. Particle size distribution is often determined by either wet sieving the sample, the hydrometer method, the pipet method, settling techniques, and X-ray absorption. The pipet method may be superior to the hydrometer method. Combinations of multiple methods may provide refined measurements of particle size distribution. Percent gravel, sand, silt, and clay are determined as apparent distribution using a minimum sediment sample size of 100 g taken from a homogenized sediment sample. Organic matter should be removed prior to analysis by oxidation using hydrogen peroxide. Wet-sieving followed by dry sieving (mechanical shaking) separates the two coarse particle size groups. The silt-clay fraction is subdivided using a pipet technique that depends upon the differential settling rates of the two different particle size fractions. All fractions are dried to a constant weight. Cooled samples are stored in a desiccator and weighed.

7.10.4 Creation of data base

In the Excel sheet, location, date, time weather, name of surveyor, sediment quality data and remarks are inserted. Results of sediment analyses for each variable for stations are tabulated in a table. Different statistical measures such as mean values, mins, maxs, st. dev. are also calculated and presented in the same table.

7.11 Water level

7.11.1 Survey period

Water level is automatically recorded by instrument every hour and surveyor read every month.

7.11.2 Survey organization

PSO and DOE Guilan

7.11.3 Survey method

There are four measuring gages at Selkeh, Sorkhankol, Siahkeshim (these are installed by DOE Guilan) and estuary (by PMO), shown in Figure 7.2. The water level is measured and accumulated by water level measuring instrument every hour. An expert goes to the stations every month, and reads the recorded data using handy equipment. The read data is converted to excel format.

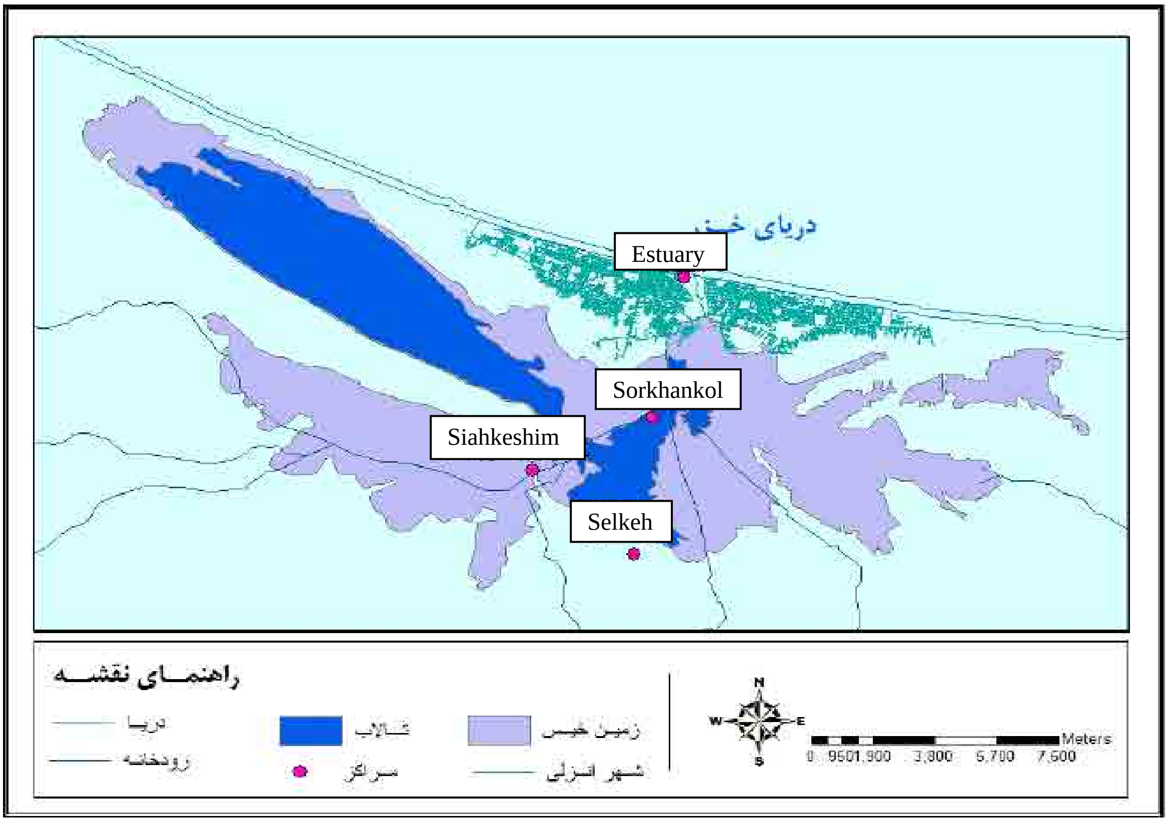


Figure 7.2 Location of Water Level Measuring Gage

7.11.4 Creation of database

In the Excel sheet, location, date, time water level data and remarks are typed.

7.12 Economic items

7.12.1 Survey period

Fishery, agriculture and hunting are surveyed once in a year, and tourism is surveyed in four seasons.

7.12.2 Survey organization

Fishery: Fishery department

Agriculture: MOJA

Hunting: DOE Guilan

Tourism: GCHHTO (Ecotourism Association)

7.12.3 Survey method

(1) Fishery

Fishery department carries out the hearing at markets every month. Surveyors take survey sheets and record the names of species and amount of each species.

(2) Agriculture

MOJA collects the rice crop for each cultivation form in Anzali and Somehsara cities. The information has been collected so far, therefore the activity must be continued.

(3) Hunting

DOE Guilan license issue section estimates the hunting amount from the number of licenses. In addition, staff of the section goes to the markets with survey sheet and ask the approximate number of hunted birds by species.

(4) Tourism

GCHHTO (Ecotourism Association) records the number of visitors to the wetland through information like the passing vehicles from cities, capacity of hotels, motels and villas, and the capacity of boat cooperatives.

7.12.4 Creation of database

Raw data is provided from the above organizations to the data handling section. Data handling unit makes database with modifying the monitoring database sheet for other items.

8. Training Needs

8.1 Capacity required for implementation of the monitoring

In order to implement the monitoring described in this manual, the monitoring capacities of relevant organizations must be developed, because their monitoring tasks will increase. The required capacities are listed in Table 8.1 below.

Table 8.1 Required Capacities

Activity	Capacity	Item	Organization
Preparation	Planning	All items	All relevant organizations
Field work	Sampling	All items	All relevant organizations
	Identification and counting of species	Birds, fish, macrophyte	DOE Guilan and NIWAI
	Quality control and quality assurance	Water quality and sediment quality	DOE Guilan, MoJA and GRWO
Sample analysis	Operation of analytical instruments	Water quality and sediment quality	DOE Guilan, MoJA and GRWO
	Identification and counting of species	Fish, macrophyte, plankton and benthos	NIWAI
	Quality control and quality assurance	Water quality and sediment quality	DOE Guilan, MoJA and GRWO
Data analysis	Data base	All items	All relevant organizations
	Compilation with standard	Water quality and sediment quality	All relevant organizations
	Multivariate analysis	All items	All relevant organizations
Reporting	Evaluation of monitoring and recommendation to management	All items	All relevant organizations

Note NIWAI: National Inland Water Aquaculture Institute, GRWO: Guilan Regional Water Organization

8.2 Training required

Training is required to develop the capacities listed in Table 8.1. Training should basically be carried out on the job (OJT) using experts who know the monitoring method written in this manual. However, new monitoring methods are innovated day by day, therefore opportunities to discuss monitoring methods among experts in the same field should be created. Furthermore, there are few staff who are familiar with the data analysis and reporting described in this manual. A workshop and a series of seminar should therefore be held, in particular during the initial stage of training. The outline of the seminar for the training is shown below.

Training items: Necessary capacity listed in Table 8.1

Period: Two weeks (10 days)

Style: Lecture (4 days), field work (2 days), laboratory work (1 day), practical (2 days), reporting (1day)

Trainer: Senior experts, lecturers and professors, and local specialists

Trainee: Experts and staff of relevant organizations

9. Budget for Monitoring

The annual cost estimated for bird, fish, macrophyte, plankton, benthos and water quality survey is shown in Table 9.1 to 9.6. The necessary budget was estimated for the responsible organizations to conduct the surveys that they can not conduct with their present budget.

9.1 Bird survey

Table 9.1 Cost of Bird Survey

Content	Cost (Rial)
Personnel cost , Petrol ,Consumed materials	153,40,000
Non-Consumed materials	159,000,000
Total cost	312, 400,000

Source: DOE Guilan

9.2 Fish survey

Table 9.2 Cost of Fish Survey

Content	Cost (Rial)
Personnel cost , Petrol ,Consumed materials	209,000,000
Non-Consumed materials	306,600,000
Total cost	515,600,000

Source: DOE Guilan

9.3 Macrophyte survey

Table 9.3 Cost of Macrophyte Survey

Content	Cost (Rial)
Personnel cost , Petrol ,Consumed materials	184,000,000
Non-Consumed materials	191,600,000
Total cost	375,600,000

Source: DOE Guilan

9.4 Plankton and Benthos survey

Table 9.4 Cost of Plankton Survey

Content	Cost (Rial)
Personnel cost , Petrol ,Consumed materials	240,000,000
Non-Consumed materials	30, 000, 000
Total cost	270,000,000

Source: DOE Guilan

9.5 Water and sediment quality survey

Table 9.6 Cost of Water and Sediment Quality Survey

Content	Cost (Rial)
Personnel cost , Petrol ,Consumed materials	336,000,000
Non-Consumed materials	650,000,000
Total cost	986,000,000

Source: DOE Guilan

Attachments

Attachment 1: Candidate Indicators and their Match with Criteria

Table A1.1 Candidate Biological Indicators and Criteria

Type	Indicator	Criteria			
		a	b	c	D
Birds	Population and number of species	✓	✓		✓
	Terns	✓			✓
	Dalmatian Pelican	✓		✓	✓
	Pygmy Cormorant	✓		✓	✓
	Whooper Swan	✓			✓
	Ferraginous Duck	✓	✓	✓	✓
	Common Coot	✓	✓		✓
	White Tailed Eagle	✓		✓	✓
Fish	Catch per unit effort	✓	✓		✓
	Esox lucius	✓	✓		✓
	Vimba vimba persa	✓	✓	✓	✓
	Cyprinus carpio	✓	✓		✓
	Abramis brama	✓	✓		✓
	Rutilus rutilus	✓	✓		✓
	Rutilus frisii kutum	✓	✓		✓
Macrophyte	*Azola*.sp (Area)	✓			✓
	Phragmites australis (Area)	✓			✓
	Trapa natans (Area)	✓			✓
Phytoplankton	Biomass and genus (mg/L)	✓			✓
Zooplankton	Biomass and genus (mg/L)	✓			✓
Benthos	Biomass and genus (g/m^2)	✓			✓

Table A1.2 Candidate Chemical Indicators and Criteria

Type	Indicator[a]	Criteria			
		a	b	c	D
Water and Sediment quality	pH (W)			✓	✓

	DO (W)	✓	✓	✓	✓
	E.C. (W)		✓	✓	✓
	T.P. (W, S)	✓	✓	✓	✓
	T.N. (W, S)		✓	✓	✓
	BOD (W)	✓		✓	✓
	COD (W)	✓		✓	✓
	Chlorophyll a (W)	✓		✓	✓
	Coliforms (W)		✓	✓	✓
	Pb (W, S)	✓	✓	✓	
	Cd (W, S)	✓	✓	✓	
	Cr6+ (W, S)		✓	✓	
	As (W, S)	✓	✓	✓	
	Hg (W, S)	✓	✓	✓	
	Ni (W, S)	✓	✓	✓	
	Cu (W, S)		✓	✓	
	Fe (W, S)	✓	✓	✓	
	CN (W)		✓	✓	
	Sulfide (W)	✓	✓		
	Sulfate (W)	✓	✓		
	EH (W)	✓	✓		
	TPH (W, S)	✓			
	PAHs (S)	✓	✓	✓	
	Pesticides (W, S)	✓	✓		
	TDS (W)	✓	✓	✓	
	TOC (S)		✓	✓	

[a] W; Water, S: Sediment

Table A1.3 Candidate Physical Indicators and Criteria

Type	Indicator[a]	Criteria			
		a	b	c	
Water and Sediment quality	Temperature		✓	✓	
	TSS	✓	✓	✓	
	Water depth		✓	✓	

	Particle size distribution (e.g., percent sand, silt and clay) (S)		✓	✓	
Water volume	River flow rate		✓	✓	
Water level	Water level	✓		✓	

[a] W; Water, S: Sediment

Table A1.4 Candidate Economic Indicators and Criteria

Type	Indicator	Criteria			
		a	b	c	
Fishery	Fish catch	✓	✓	✓	
Agriculture	Rice production		✓	✓	
Hunting	Hunting amount (number of birds)	✓	✓	✓	
Tourism	Tourists to the wetland	✓		✓	

Attachment 2: Method of Data Analysis

(1) Compilation with standard values

Water quality data was compared with standard values as shown in Table A1.1. The dataset for the compilation was provided from JICA master plan study[6]. Since there is no standard for the surface water in Iran, Canadian standard is mainly used because most of standard values are available with Canadian standard. US and UNDP[7] standards were also applied complementally.

[6] Biological and water quality surveys were conducted by JICA from 2003 to 2004, and the results in August 2003 were used for this analysis.
[7] Japanese standard is from UNDP standard

Table A2.1 Water Quality Data and Standard Values

SITE		AITE	WATE	WADE	DO	pH	COD	BOD	T-N	T-P	Feco	Cd	Pb	Cr6+	As	Hg	NI	Cu	Fe	CN
Standard Value *1		-	*4	-	5.5	6.5-9.0	30 (*2)	5 (*4)	1	0.05	770 (*2)	0.0001	0.001	0.001	0.005	0.0001	0.025	0.002	0.3	0.005
Selkeh	(PW15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East	W1 (PW1)	27	24.8	1.50	5.40	7.3	54.0	15	1.321	0.371	90	0.004	0.018	n.d.	0.0300	n.d.	0.031	0.703	0.154	n.d.
	W2 (PW2)	27	25.7	0.90	7.49	7.6	25.0	12	2.582	0.173	23	0.002	0.011	n.d.	0.0110	n.d.	0.007	0.403	0.185	n.d.
	Mean	27	25	1.20	6.45	7.5	39.5	14	1.952	0.272	57	0.003	0.015	n.d.	0.0205	n.d.	0.019	1.106	0.170	n.d.
Central	W3 (PW5)	27	26	1.50	6.23	7.5	32.6	11	1.968	0.405	2400	n.d.	n.d.	n.d.	0.0044	n.d.	0.002	0.239	0.210	n.d.
	W4 (PW4)	26	25.7	1.50	5.90	7.4	23.0	11	2.026	0.390	4600	n.d.	n.d.	n.d.	0.0110	0.0009	0.004	0.338	0.212	n.d.
	W5	28	26.5	3.00	5.64	7.3	61.0	12	2.832	0.209	40	n.d.	n.d.	n.d.	0.0020	n.d.	0.002	0.339	0.060	n.d.
	W6 (PW3)	29	26.8	2.30	5.76	7.5	67.0	17	2.184	0.206	1500	n.d.	n.d.	n.d.	0.0130	n.d.	0.017	0.144	0.045	0.062
	W7 (PW7)	29	26.8	6.00	7.10	7.7	17.0	15	1.115	0.150	40	n.d.	n.d.	n.d.	0.0050	n.d.	0.239	0.239	0.119	n.d.
	W8 (PW8)	26.5	26.1	1.90	7.27	8.3	67.0	8	1.891	0.063	4	n.d.	n.d.	n.d.	0.0350	n.d.	0.003	0.093	0.091	0.051
	Mean	28	26	2.70	6.32	7.6	44.6	12	2.003	0.237	1,431	n.d.	n.d.	n.d.	0.0117	0.0009	0.0445	1.392	0.123	0.0565
Siahkeshim	W12 (PW13)	27	24.1	1.50	7.65	6.4	50.0	3	2.552	18.992	930	n.d.	0.004	n.d.	0.0020	n.d.	n.d.	0.062	0.067	n.d.
	W13 (PW12)	27.5	24.6	1.75	7.60	6.9	22.0	4	2.063	0.205	30	n.d.	n.d.	n.d.	0.0030	n.d.	n.d.	0.058	0.012	n.d.
	W14 (PW14)	27.5	24.4	0.90	8.13	7.0	26.0	3	0.287	0.127	40	n.d.	n.d.	n.d.	0.0060	n.d.	n.d.	0.126	0.018	n.d.
	Mean	27.3	24.4	1.38	7.79	6.8	32.7	3.3	1.634	6.441	333.3	n.d.	0.0	n.d.	0.0037	n.d.	n.d.	0.246	0.032	n.d.
Lagoon(West)	W9 (PW11)	27	26.6	1.80	6.20	8.7	56.0	3	2.768	0.041	<3	n.d.	0.003	n.d.	0.0010	n.d.	n.d.	0.186	0.033	n.d.
	W10 (PW9)	27	25.8	1.90	7.22	8.4	38.0	6	1.693	0.236	>3	n.d.	0.003	n.d.	0.0030	n.d.	n.d.	0.086	0.008	n.d.
	W11 (PW10)	27	25.8	1.90	7.82	8.6	63.0	3	3.339	0.064	<3	n.d.	n.d.	n.d.	0.0060	n.d.	n.d.	0.059	0.008	0.0004
	Mean	27.0	26.1	1.87	7.08	8.6	52.3	4.0	2.600	0.114	n.d.	n.d.	0.0	n.d.	0.0033	n.d.	n.d.	0.331	0.016	0.000
Sorkhankol	W15 (PW16)	27.5	24.5	0.95	7.14	6.8	19.0	4	3.574	0.173	40	n.d.	n.d.	n.d.	0.0020	n.d.	n.d.	0.044	0.028	n.d.
	Mean	28	25	0.95	7.14	6.8	19.0	4	3.574	0.173	40	n.d.	n.d.	n.d.	0.0020	n.d.	n.d.	0.044	0.028	n.d.
River	R1 (PR17)	27	26.4	0.32	6.53	7.7	42.0	9	1.486	0.250	2400	n.d.	n.d.	n.d.	0.0020	n.d.	0.004	0.105	0.010	n.d.
	R2 (PR2)	27	26	0.40	8.73	7.9	36.0	7	1.756	0.116	930	n.d.	0.012	n.d.	0.0050	n.d.	0.009	0.045	1.175	n.d.
	R6 (PR5)	31	28.7	0.15	7.94	7.0	48.0	9	2.483	0.087	40	n.d.	n.d.	n.d.	0.0020	n.d.	n.d.	0.068	0.299	n.d.
	R7 (PR6)	34	26.7	0.40	6.87	7.8	38.0	8	1.445	0.110	4600	n.d.	n.d.	n.d.	0.0050	n.d.	n.d.	0.007	0.400	n.d.
	R10 (PR8)	31	28.6	0.30	7.66	7.7	46.0	11	1.377	0.112	>2400	n.d.	n.d.	n.d.	0.0010	n.d.	0.004	0.085	1.107	n.d.
	R13 (PR13)	35	26.8	0.20	7.10	7.3	42.0	21	1.082	0.809	24000	0.007	n.d.	n.d.	0.0003	n.d.	0.014	0.006	0.048	0.049
	R19 (PR16)	30	26	0.30	5.30	7.3	27.0	17	3.205	0.945	11000	0.008	0.022	n.d.	0.0040	0.0042	0.057	0.9	0.592	0.009
	R20 (PR20)	30	25.2	0.25	6.34	7.6	15.0	6	2.191	0.182	11000	n.d.	n.d.	n.d.	0.0180	n.d.	0.008	0.067	0.346	n.d.
	Mean	31	27	0.29	7.06	7.5	36.8	11	1.878	0.326	7,710	0.008	0.017	n.d.	0.0047	0.0042	0.0160		0.497	0.0290

*1: Canadian Water Quality Guidelines for the Protection of Aquatic Life, 2007
*2: USEPA surface water quality criteria, 1999
*3: OECD Cooperative Programme on monitoring of Waters,Synthesus report, 1980
*4: not to be increased by more than 3 ℃ above ambient water temperature
Note AITE: Air temperature, WATE: Water temperature, WADE: Water depth, Feco: Fecal coliform, (PW): Sampling station of plankton and benthos survey

2) Principal component analysis

Principal component analysis (PCA) implies the structure of the multivariate condition such as in an ecosystem. The dataset for the analysis was provided from JICA master plan study. The dataset was calculated with Microsoft Excel. The output is shown in Table A1.2.

Table A2.2 Principal Component Loading

Item	1st PC	2nd PC	3rd PC	4th PC	5th PC	6th PC
PHBI	0.330813415	0.130143115	0.501935717	0.288846602	0.295894091	-0.05039233
PHGE	0.28221611	0.738066095	-0.15813096	-0.02204284	0.034281547	0.308294277
ZOBI	-0.68687369	0.249109492	0.186760206	-0.31608796	0.145729663	0.463971255
ZOGE	-0.70272657	0.170301682	0.012630101	-0.1743956	-0.31743175	0.455327911
BEBI	-0.45210506	-0.32214878	0.190767247	-0.19646218	0.579724506	-0.00437524
BEGE	-0.49279367	-0.48554494	0.021911489	0.022875641	0.596682101	-0.18207456
AITE	0.182395566	0.661901873	-0.06845524	-0.5110541	-0.15669339	-0.18410788
WATE	-0.11356808	0.819709475	0.154072362	0.328422471	0.274944895	0.163809559
WADE	0.131995187	0.814029442	-0.20283789	-0.28265853	0.094866502	-0.19325483
DO	0.570823532	-0.35705114	0.119514175	-0.43576753	0.385109427	-0.06577845
pH	0.058102061	0.429099017	0.562653276	0.374567244	0.384324013	0.257278855
COD	-0.00427569	0.162058875	0.666933288	0.416566695	-0.46215928	-0.08988099
BOD	-0.70313681	0.595040794	-0.17436751	0.035676625	-0.05901779	-0.20965783
T-N	0.173761918	-0.15022687	0.156398687	0.184554214	-0.21057882	0.710293578
T-P	0.193749354	-0.3891268	-0.18382312	-0.14945597	-0.54933347	-0.10198891
FECO	-0.21278761	0.000628125	-0.70157968	0.65201809	-0.07056119	0.047041441
Cd	-0.82521104	-0.1734061	0.241023168	-0.2653513	-0.16914931	-0.09949506
Pb	-0.76252029	-0.26283968	0.295428019	-0.27976214	-0.19263616	-0.05041784
As	-0.57676148	0.085731827	0.397798584	0.277775438	-0.08466665	-0.47692384
Hg	-0.15489415	-0.14368568	-0.63207106	0.641035926	0.192064744	-0.10256487
NI	-0.04889557	0.706250568	-0.30633342	-0.47025127	0.126407411	-0.19479108
Fe	-0.80205778	0.066115636	-0.44565009	0.168573279	0.110183073	0.118451388
CN	-0.02386386	0.40781057	0.364363094	0.411721669	-0.17870415	-0.39530534
Eigenvalue	4.867495715	4.427509139	2.903287613	2.744649702	2.045995694	1.749768139
Contribution rate	21.16302485	19.25003974	12.62298962	11.93325958	8.89563345	7.607687559
Cumurative contribution rate	21.16302485	40.41306458	53.0360542	64.96931378	73.86494723	81.47263479

Note PC: Principal component, PHBI: Phytoplankton biomass, PHGE: Phytoplankton genus, ZOBI: Zooplankton biomass, ZOGE: Zooplankton genus, BEBI: Benthos biomass, BEGE: Benthos genus, AITE: Air temperature, WATE: Water temperature, WADE: Water depth, FECO: Fecal coli forms

If the absolute value of a principal component loading exceeds 0.5, it means the item is correlated with the principal component. 1st principal components comprise zooplankton, DO, BOD, Cd, Pb, As and Fe. Though the values of Arsenic and Cyanide tended to be less than their standard values, they are included in the 1st principal component. Arsenic should be left as an indicator. On the other hand, the absolute value of Cyanide did not exceed 0.5 between 1st and 6th principal components. This implies that the item does not work significantly in the wetland ecosystem. The 2nd principal component implies the correlation between phytoplankton and temperature (air and water). Contribution rates of 1st and 2nd principal components are close. It is inferred that two mechanisms related to nutrients and temperature occur in the ecosystem of Anzali wetland.

The analysis suggests that both chemical and physical indicators are important for the monitoring of wetland condition, but Cyanide can be omitted from the initial list of indicators.

(3) Regression analysis

Regression analysis is a technique used for the modeling and analysis of numerical data consisting of values of a dependent variable (response variable) and of one or more independent variables (explanatory variables). Regression can be used for prediction, hypothesis testing, and modeling of causal relationships.

In order to select the indicators, a scenario was prepared as follows. Large creatures such as birds, fish and plants are directly affected by the all environmental condition. Plankton and benthos are affected by trophic condition in water, that is, eutrophic condition is changing the movement of plankton and benthos at the Anzali wetland. The value of items are indirectory shown by the concentration of heavy metals, because the value of heavy metals is affected by the polluton load such as waste water, solid waste and agricultural discharge.

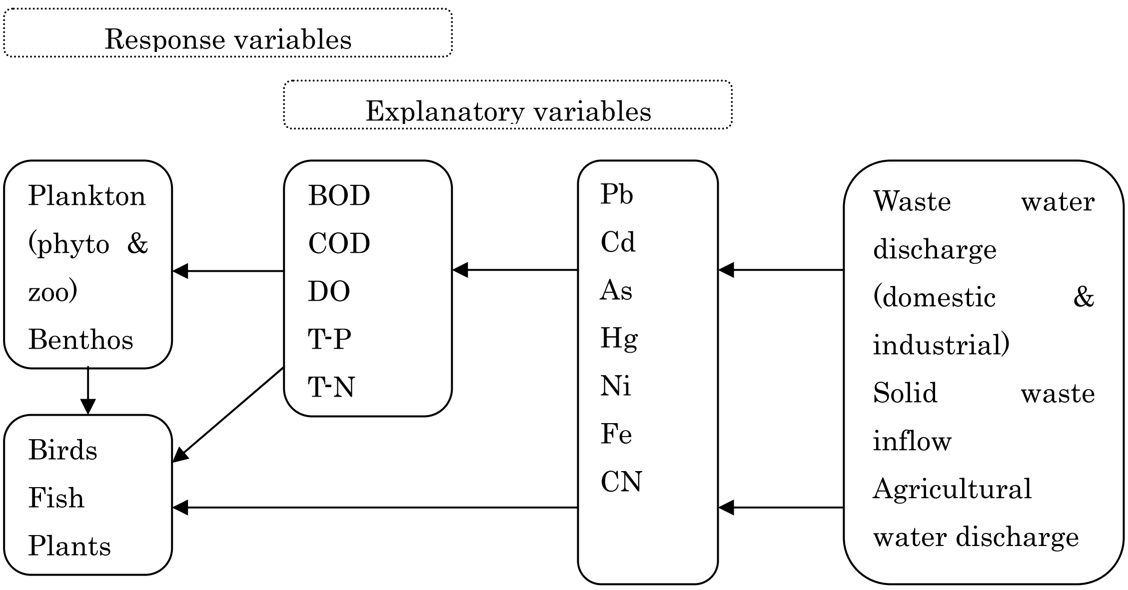


Figure A2.1 Response variables and explanatory variables

Regression analysis was carried out with Microsoft Excel for all response variables and explanatory variables. The combination of analyses are too many to show here, so two examples are shown. Above scenario imply the correlation between pollution indicators and heavy metals (it means if the concentrations of heavy metals are changed, the value of pollution indicators are changed as well). BOD and Fe were calculated and a scatter diagram was delineated as shown in Figure A1.2. Figure A1.3 is the relation between BOD and CN. The contribution rate (R^2) fluctuated from 0 to 1, and larger number shows higher contribution. R^2 is relatively lower between BOD and CN compared to between BOD and Fe. In this process, relations among items in each principal component were confirmed.

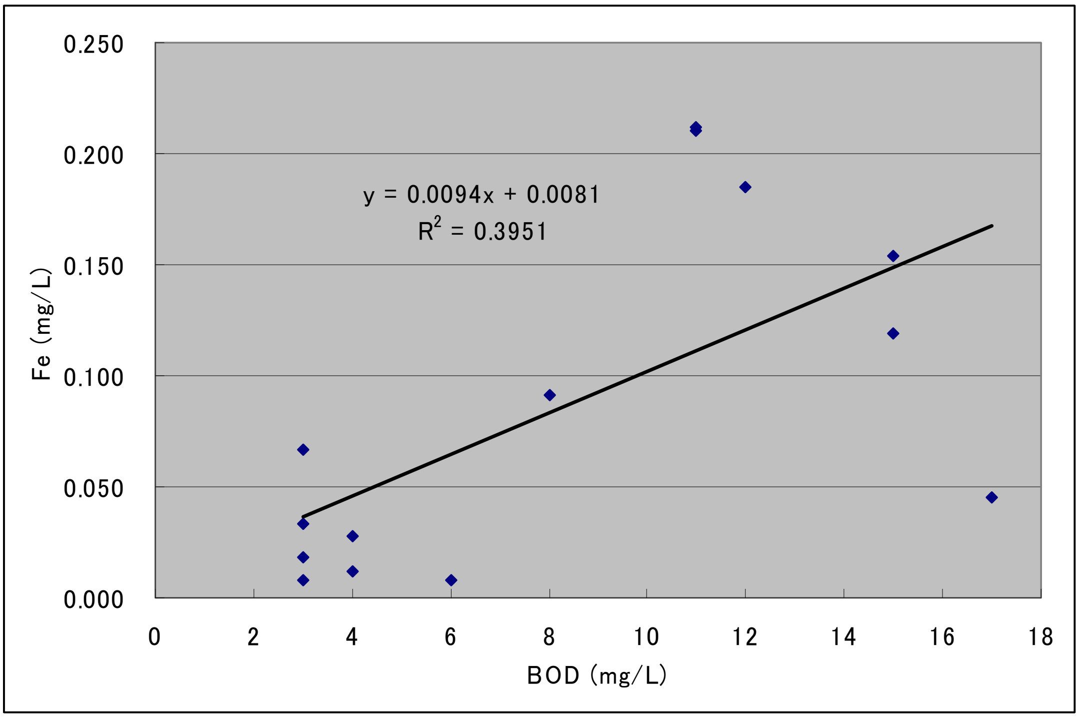


Figure A2.2 Regression line between BOD and Fe

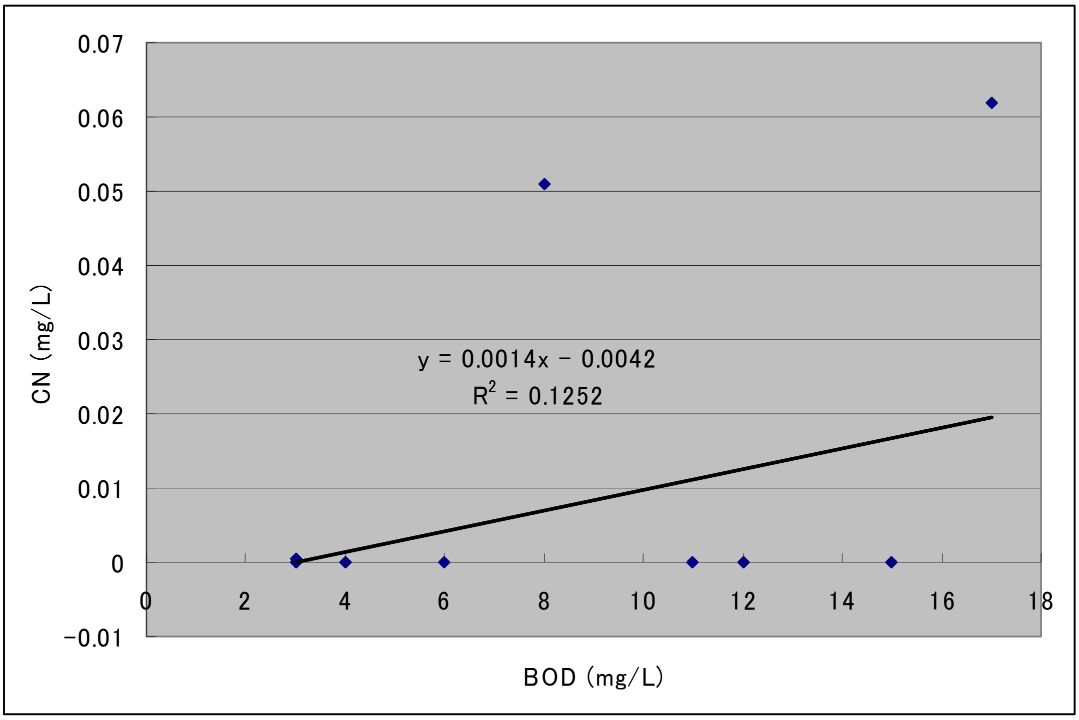


Figure A2.2 Regression line between BOD and CN

Attachment 3: Sample Report of Monitoring for Anzali wetland management committee meeting

(1) Present Condition and Countermeasure of High COD value

(This sample report is written on supposition data.)

Chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water. If the value rises, it is estimated that organic pollution is proceeding.

If organic pollution proceeds, organic compounds are decomposed in the lake and river, DO (dissolved oxygen) decreases, and it produces uncomfortable odor and occur death of fish. The outline is shown in Figure A2-1.

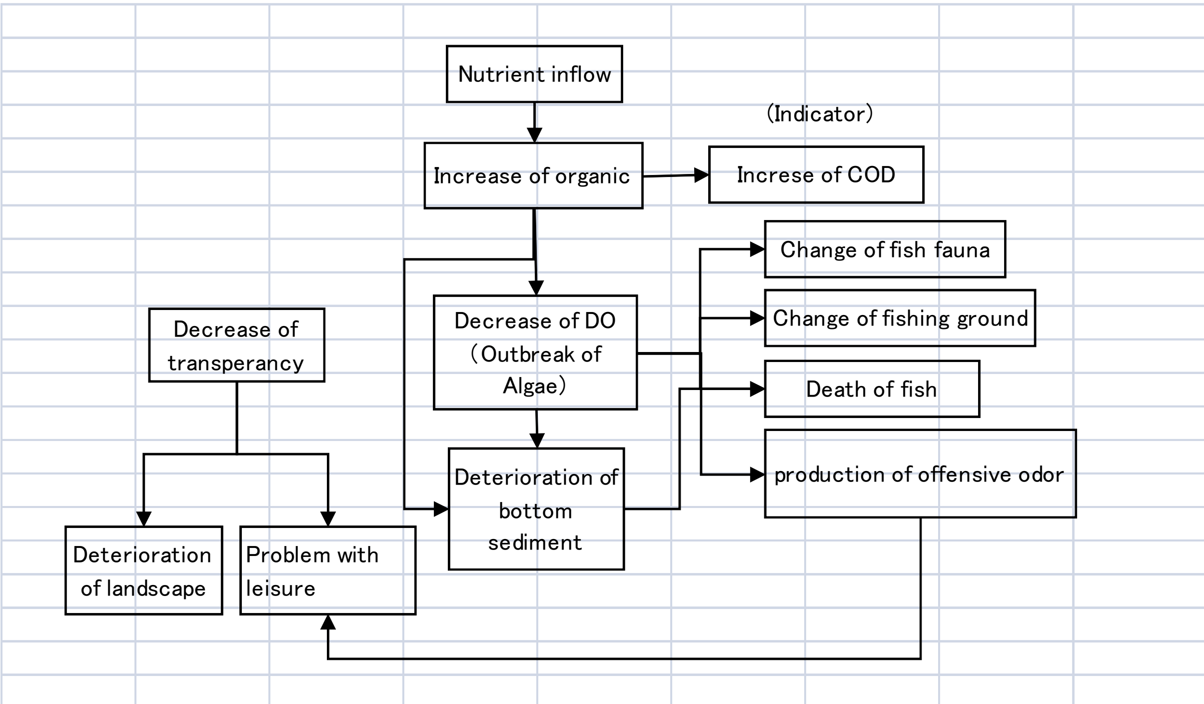


Figure A2-1 Flow of the Organic Pollution

(2) Monitoring result

1) Annual change of COD at the Anzali wetland

Water quality monitoring was conducted at the monitoring stations W1 – W10. The annual change of COD in 2008 is shown in Table A2-1 and Figure A2-2.

The average was 27.78 mg/L, and most of stations exceeded the standard value (30 mg/L) in summer.

Table A2-1 Annual Change of COD

COD (Unit: mg/L) (Standard: *30*)

Sampling Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	Max	Min	No. over standard
W-1	23.00	26.00	28.00	30.00	33.00	35.00	36.00	38.00	35.00	31.00	27.00	25.00	30.58	38.00	23.00	**6**
W-2	21.00	23.00	22.00	25.00	27.00	29.00	31.00	32.00	30.00	27.00	25.00	23.00	26.25	32.00	21.00	**2**
W-3	26.00	29.00	28.00	31.00	34.00	38.00	41.00	44.00	43.00	38.00	35.00	31.00	34.83	44.00	26.00	**9**
W-4	18.00	19.00	19.00	22.00	25.00	26.00	26.00	27.00	27.00	25.00	21.00	19.00	22.83	27.00	18.00	**0**
W-5	23.00	24.00	24.00	25.00	28.00	30.00	31.00	33.00	32.00	28.00	26.00	24.00	27.33	33.00	23.00	**3**
W-6	24.00	22.00	23.00	26.00	27.00	29.00	31.00	29.00	28.00	26.00	25.00	24.00	26.17	31.00	22.00	**1**
W-7	26.00	25.00	28.00	27.00	31.00	35.00	37.00	40.00	36.00	32.00	28.00	26.00	30.92	40.00	25.00	**6**
W-8	19.00	17.00	18.00	23.00	21.00	24.00	27.00	29.00	27.00	25.00	21.00	18.00	22.42	29.00	17.00	**0**
W-9	23.00	24.00	24.00	27.00	29.00	32.00	33.00	35.00	31.00	27.00	25.00	22.00	27.67	35.00	22.00	**4**
W-10	24.00	26.00	27.00	27.00	29.00	31.00	32.00	33.00	33.00	30.00	28.00	25.00	28.75	33.00	24.00	**4**
Average	22.70	23.50	24.10	26.30	28.40	30.90	32.50	34.00	32.20	28.90	26.10	23.70	27.78	34.20	22.10	3.5

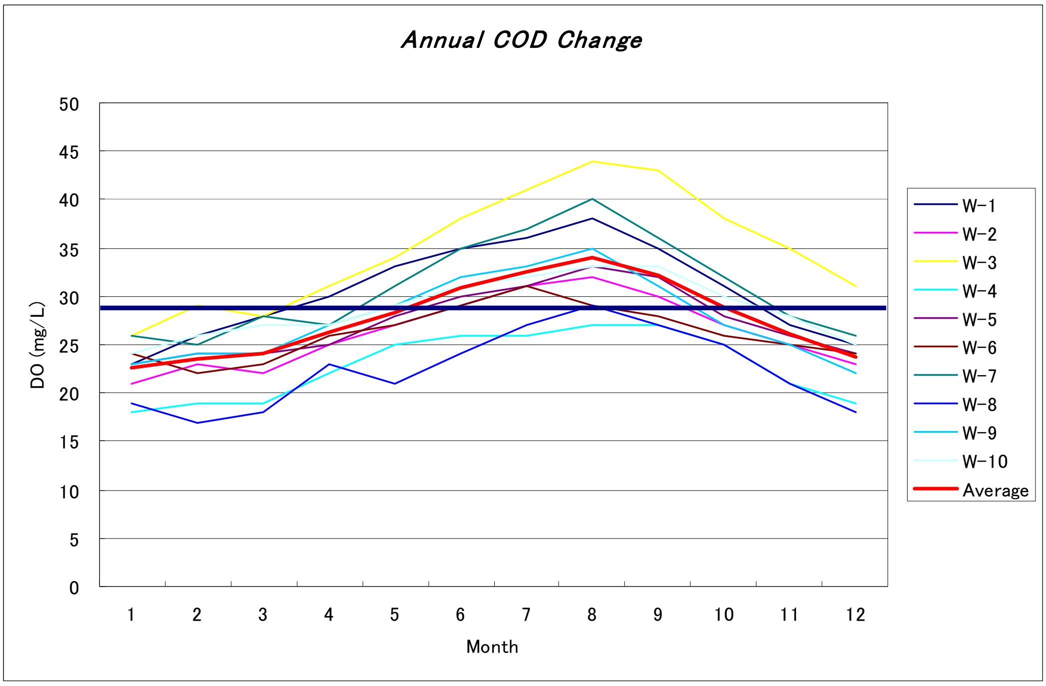


Figure A2-2 Annual Change of COD

2) Stations exceeded standard value

Stations exceeded standard value are shown in Figure A2-3. The stations in which over standard period was long were mainly east and north east area. There is an industrial area at east side of the wetland, and rivers from Rasht are flowing into north east area. The effect of the industrial area and wastewater from Rasht is inferred.

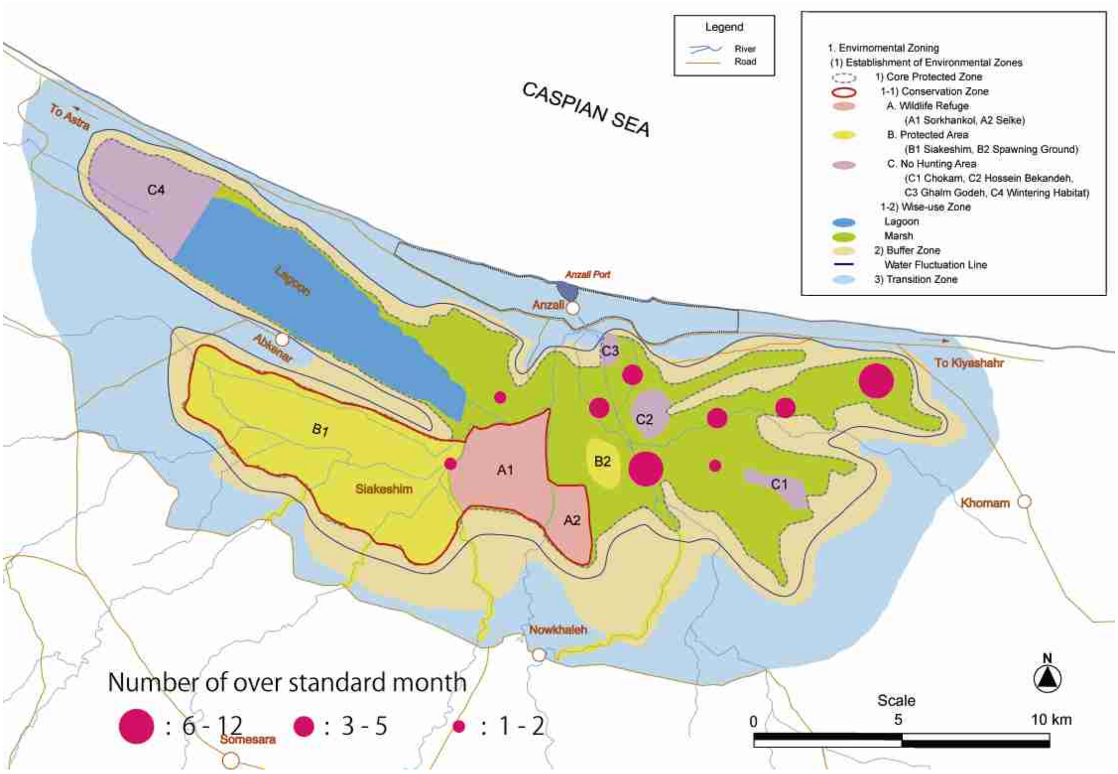


Figure A2-3 Stations Exceeded Standard Value

3) Relation between other parameters

Principal component analysis (PCA) was carried out to extract the group including COD using monitoring data. As a result of analysis, COD comprised 3rd principal component, contribution rate of which is 12.62%, and other items in the component were phytoplankton, pH, fecal coliform and Hg.

Regression analysis between COD and other items were carried out to understand the relation, and 2 items, phytoplankton and pH, showed higher positive relation with COD as shown in Figure A2.4. It implies that something which raises pH is the cause of high COD value.

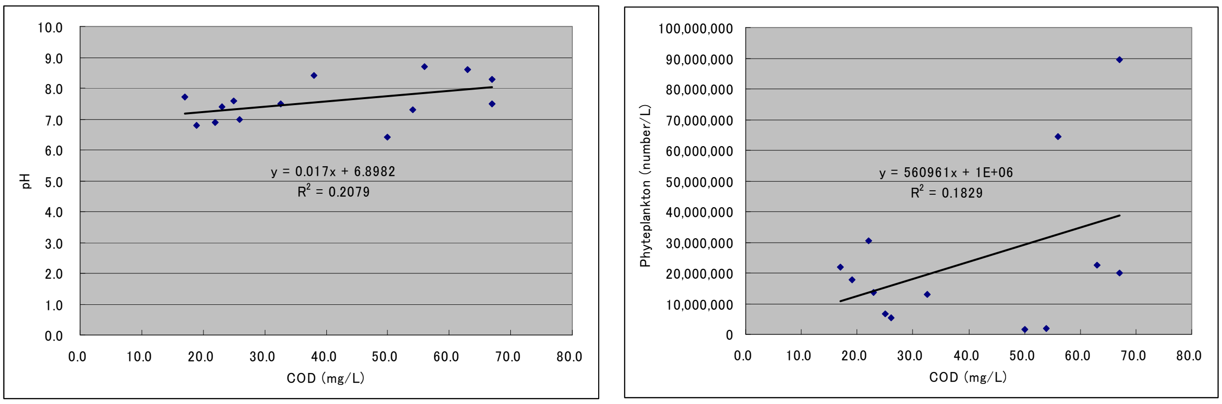


Figure A2.4 Regression Lines between COD and Phytoplankton and COD and pH

(3) Issues

1) Impact to creatures

Biomass and the number of species might decrease. Threatened species might extinct. Fishery might have negative impacts.

2) Production of offensive odor and deterioration of landscape

The environment for eco-tours might be deteriorated. It makes worse the life of residents who live near the wetland

3) Cause of the issues

Number of pH is especially raised with the discharge from --- production plant. The plants are located at the west side of the wetland and north side of Rasht. Those plants may cause the issues. According to the results of industrial sewage monitoring by DOE Guilan, a specific plant was not identified as the cause of the issues, but --- plants are discharging relatively high concentration of ---.

COD usually rise with any sewage such as industrial, agricultural and domestic wastewater. Those comprehensive impacts must be a part of the cause of COD rise.

(4) Proposed measures

1) Industrial discharge

The discharge of --- plants should be monitored carefully. The outlet should not be to the wetland, therefore, sewer system should be changed focusing on the discharge of --- plants. Basically, outlets from plants near the wetland should not be toward the wetland. The sewage system should be changed.

2) Agricultural discharge

River bed should be covered by plants, in particular, at riparian zone in order to prevent the direct inflow of sediment from agriculture land.

3) Domestic discharge

Government should instruct people not to flow out cooking oil and garbage from their kitchen.

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