MEKONG RIVER COMMISSION FOR SUSTAINABLE DEVELOPMENT

MRC

GUIDANCE ON IRRIGATION ASSET MANAGEMENT

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Mekong River Commission

Guidance on Irrigation Asset Management

December 2024

Title: Guidance on Irrigation Asset Management

DOI: 10.52107/mrc.c20du6

Keywords: irrigation/facilities/asset management/deteriorated/working life longer/Lower Mekong Basin/Mekong River Commission

For bibliographic purposes, this volume may be cited as:
Mekong River Commission. (2024). *Guidance on Irrigation Asset Management.* Vientiane: MRC Secretariat. DOI: 10.52107/mrc.c20du6

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Citation

Mekong River Commission. (2024). *Guidance on Irrigation Asset Management*. Vientiane: MRC Secretariat. DOI: 10.52107/mrc.c20du6

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ABBREVIATIONS AND ACRONYMS

ADCA	Agricultural Development Consultants Association of Japan
AI	Artificial Interigence
BCP	Business Continuity Plan
DOI	Department of Irrigation
GIS	Geographic Information System
GPS	Global Positioning System
IAM	Irrigation Asset Management
MAF	Ministry of Agriculture and Forestry
O&M	Operation and Maintenance
OJT	On the Job Training
UAV	Unmanned Aerial Vehicle

EXECUTIVE SUMMARY

In the MRC Member Countries, a lot of irrigation facilities have been built since the 1970s, which contributed to expansion of irrigated area, increasing amount of agricultural products, improving livelihoods of people living in rural areas and ensuring food security.

However, many of these developed irrigation facilities have deteriorated according to the time passed. The irrigation facilities with lowered functions are increasing.

As opposed to the huge amount of stock of irrigation facilities, budget and human resources for renew and rehabilitation of the deteriorated irrigation facilities are very limited. Therefore, efficient maintenance, conserving functions and making the working life longer for irrigation facilities are urgent issues in the Member Countries.

This guidance introduces an Irrigation Asset Management (IAM) Technology mainly based on the developed IAM Technology in Japan that faced the above issues in irrigation sector at an earlier stage than the Member Countries. The methodology covers the basic concept of the IAM, regular operation and maintenance (O&M), function diagnosis, use of database, and deterioration prediction.

Particularly in the IAM, the development of an IAM Database is a critical requirement. The IAM Database records and stores on-site data acquired from the regular O&M, monitoring, and function diagnosis as well as repair history of irrigation facilities. The database is also useful for visualization of status and time-series changes of the irrigation facilities, which is required for preparing proper and efficient budget request and/or funding proposal for rehabilitation. This is a core of evidence-based budget planning and request for required actions and countermeasures for the deteriorated irrigation facilities. This guidance also introduces an example of the IAM Database that is already available in some of the Member Countries.

Recording and storing the past results of function diagnosis and soundness levels of an irrigation facility in the IAM Database enables to verify if the reason of the judgement of the soundness level was reasonable or not by comparing the current status of the irrigation facility with the past record of the function diagnosis, which would lead to continuous improvement of the IAM technology. In addition, this accumulation of data and experience on the IAM will be important technical assets for the organization.

On another note, given a large number of stocks of irrigation facilities in the Member Countries, it is impractical that the public sector is responsible for the O&M of all irrigation facilities. The cooperation with farmers, communities and water user groups including women participation is essential. The community and women participation in the IAM is expected to give a lot of policy implications on improving the irrigation facilities and on considering the more efficient O&M. In addition, it would contribute to making the working life of irrigation facilities longer through more frequent and detailed O&M.

When applying to the IAM, it is desirable that each Member Country improve and customize this guidance reflecting and incorporating individual status and conditions on irrigation

schemes in a country through accumulating knowledge and experience on the IAM. In that sense, this guidance is a living document that is to be continuously revised and improved.

It is expected that applying the IAM in the Member Countries bring efficient and proper maintenance of irrigation facilities and attribute to stable agricultural production and ensuring food security.

1 INTRODUCTION

1-1 Background

In the MRC Member Countries, a lot of irrigation facilities have been built since the 1970s, which contributed to expansion of irrigated area, increasing amount of agricultural products, improving livelihoods of people living in rural areas and ensuring food security.

However, many of these developed irrigation facilities have deteriorated according to the time passed, the irrigation facilities with lowered functions are increasing.

As opposed to the huge amount of stock of irrigation facilities, budget and human resources for renew and rehabilitation of the deteriorated irrigation facilities are very limited. Therefore, efficient maintenance, conserving functions and making the working life longer for irrigation facilities are urgent issues in the Member Countries.

Japan faced these issues in irrigation sector at an earlier stage than the Member Countries. Japan developed an IAM technology for irrigation facilities and has tackled implementing more efficient maintenance and making the working life longer for irrigation facilities.

As well as Japan, it is required for the Member Countries to maintain the functions of irrigation facilities and steadily supply irrigation water to farmlands by properly maintaining and prolonging the working life for irrigation facilities with the IAM technology.

1-2 Purpose of This Guidance

The purpose of this guidance is to give a basic guidance to maintain proper functions of irrigation facilities with prolonged working-life through the IAM.

In particular, this guidance aims: (I) to show basic items to be considered when an irrigation engineer or a government officer conducts the IAM for irrigation facilities; (ii) to enable the irrigation engineer or the government officer to propose or request required budget for repair, reinforce, rehabilitation or renewal of the irrigation facilities with clear evidence; and (iii) to be a help of further development of technical knowledge and expertise for the irrigation engineers, government officers and related organizations so that they can properly maintain the functions of the irrigation facilities.

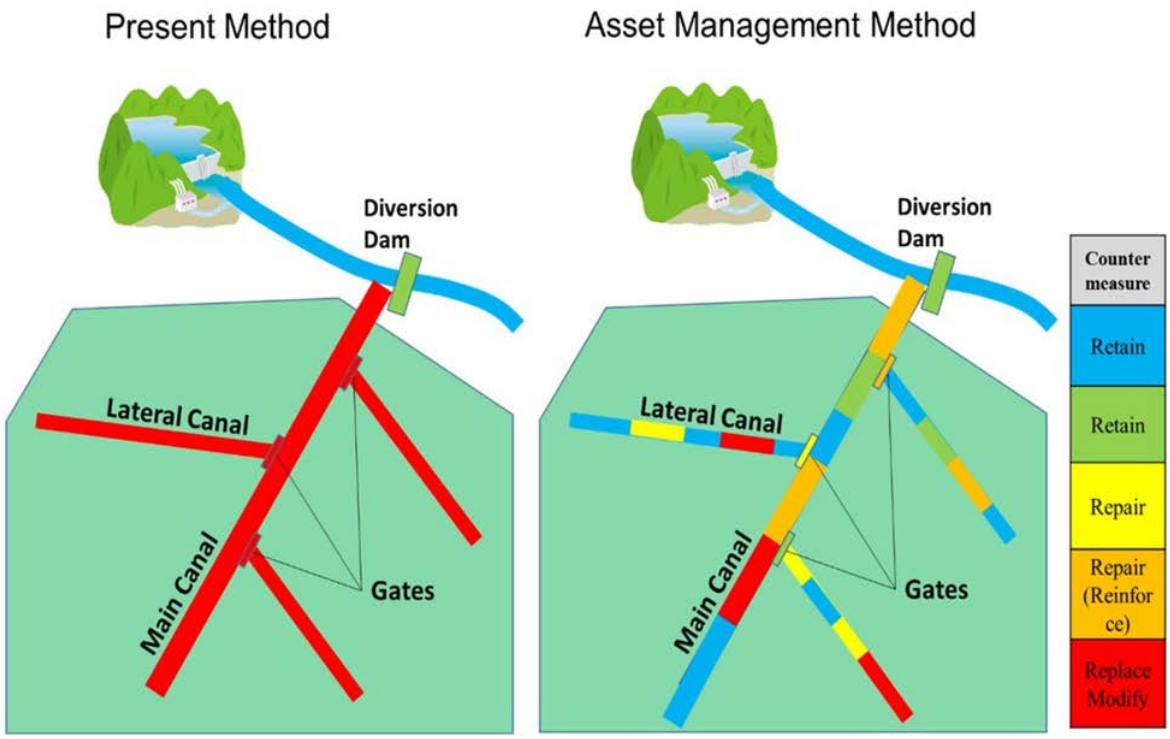
It is important to note that there is no common and unique methodology of the IAM to be applicable in any Member Country. The methodology of the IAM in this guidance is a general methodology that is needed to adjust in each Member Country according to policy and conditions of irrigation.

While the scope of this guidance is mainly for maintaining functions of irrigation facilities, it is also important to survey and consider the functions of whole irrigation scheme from reservoir, headwork, main canal, branch canal, tertiary canal to farmland through planned function diagnosis without just focusing on functions of individual irrigation facility. In addition, it is required to carefully look and consider trends and changes of farming practices, water demand and risks of natural disasters in the command area of irrigation scheme (MAFF, 2015).

Box 1. Introduced IAM in Japan

In Japan, it was common to renew a whole irrigation scheme in one time when the irrigation scheme shows significant deterioration or there was a need to upgrade the irrigation scheme according to changes of farming conditions.

However, the MAFF of Japan is promoting the IAM because stock of deteriorated irrigation infrastructures has been rapidly accumulated and there is a strong need to save the cost for maintaining functions of such deteriorated irrigation infrastructures. The IAM technology can efficiently prolong the working life of an irrigation facility by conducting proper repair, reinforce, rehabilitation or renew before the functions of the irrigation facility reach severe conditions.



Source: ADCA, 2022c

1-3 Intended Users of This Guidance

This guidance intends to be used by technical officers and engineers of central and local governments or institutions in the Member Countries engaging in maintenance of irrigation facilities. In addition, this guidance aims at introducing the IAM into their technical policy or operation.

2 RATIONALE OF INTRODUCING IRRIGATION ASSET MANAGEMENT FOR IRRIGATION INFRASTRUCTURES IN THE MEMBER COUNTRIES

2-1 Deteriorated Irrigation Infrastructures

Many irrigation projects have been implemented in the LMB since the 1970s, where hundreds of thousands of irrigation infrastructures have been installed. As a result, Irrigation areas have been expanded (MRC, 2022).

However, according to the time passed since its establishment, most of the irrigation infrastructures are old and deteriorated (Figure 1, Figure 2 and Figure 3). The deteriorated irrigation infrastructures lower their functions and increase flood and drought risks because of increasing water delivery loss, maintenance cost and decreasing carrying capacity of flooded water and structural strength against flood.

Figure 1. Cracks on canal wall

Source: MRC, 2022

Figure 2. Rusted gate

Source: MRC, 2022

Figure 3. Rusted pipes of irrigation pump

Source: MRC, 2022

Another main factor that promotes the deterioration of irrigation infrastructures is poor construction quality. It has often been observed that cracks on concrete structures generate in even newly constructed irrigation structures in the LMB (Figure 4 and Figure 5) (MRC, 2022).

Figure 4. Improper steel work

Source: MRC, 2022

Figure 5. Cracks on water gate

Source: MRC, 2022

2-2 Why is Irrigation Asset Management for Irrigation Infrastructures Required in the Member Countries?

The irrigation infrastructures are rapidly deteriorating. Without any effective measures and policies, the total stock of the deteriorated irrigation infrastructures would further increase, which will significantly bring negative impacts on agricultural productivity and resilience against natural disasters.

However, limited budget and human resources to tackle these deteriorated irrigation infrastructures is a common issue in the Member Countries. It is estimated that there are 6,596 existing irrigation headworks and existing irrigation reservoirs at 1,317 locations (MRC, 2018). Regarding irrigation water canals, total length of it is not even estimated due to its enormous length from main canals to tertiary canals.

Under this condition, how the government agency should prioritize rehabilitation, repair or improvement from such a large number of deteriorated irrigation infrastructures? Even if the major irrigation structures such as dam, headworks, main canals could be rehabilitated by the government itself or with the support by donors, all of remaining structures such as branch/tertiary canals could not be covered.

The IAM technology developed in Japan where they faced a similar issue for irrigation infrastructures earlier than the Member Countries can be a solution for the above issues, which is a purpose of developing this guidance.

Figure 6 summarizes the problems without the IAM.

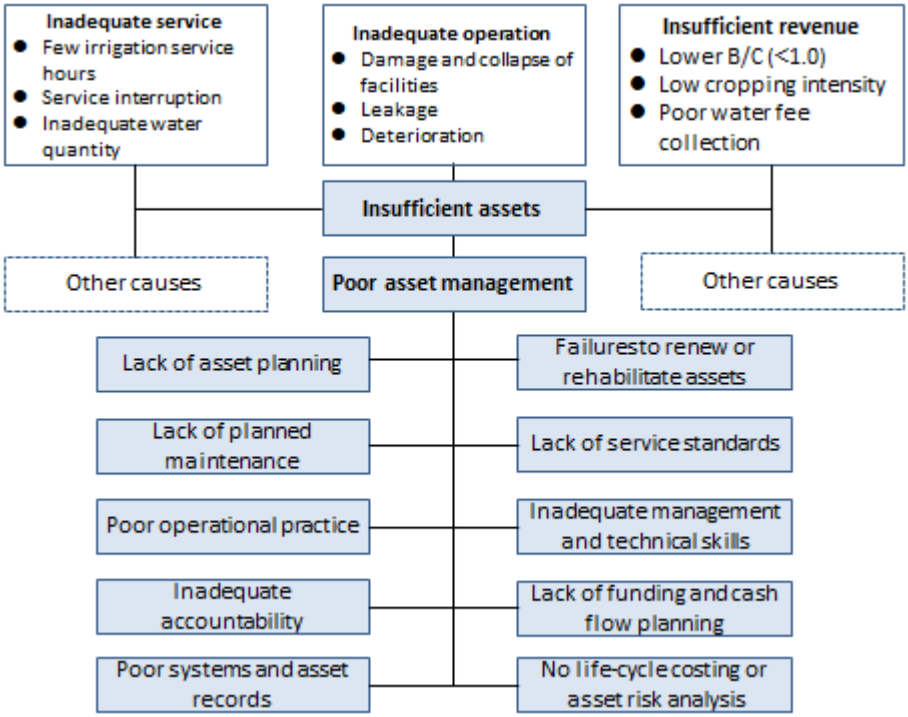


Figure 6. Problems without the IAM

Source: ADB, 2013

3 METHODOLOGY OF IRRIGATION ASSET MANAGEMENT

3-1 Overview of Irrigation Asset Management

3-1-1 Basic Concept of Irrigation Asset Management

In this guidance, the IAM is defined as a body of technique and management to make working life longer and reduce life-cycle cost of irrigation facilities with risk management by rotating maintenance activity cycle from operation and maintenance (O&M), function diagnosis, repair or rehabilitation to monitoring with a database which stores accumulated data of the maintenance activity cycle.

It is required for any irrigation facility to be renewed someday because it will not function any more or maintenance cost will significantly increase because of deterioration according to the time passed. However, the level of deterioration and changes on an irrigation facility are not the same for all parts of it. In most cases, even in one irrigation facility, there are various parts with different deterioration levels that have no measures but for renewal, whose working life can be prolonged by repair or reinforcement, or that can be still used with close monitoring. In these cases, it is more efficient to take measures timely and properly according to the conditions of the parts of the irrigation facility (MAFF, 2015).

Therefore, it is important to decide at which timing and which part we should repair, reinforce, rehabilitate or renew for the irrigation facility based on the results of regular function diagnosis and monitoring. In the IAM, we will decide measures for repair, reinforce, rehabilitate or renew considering cost, benefit, importance of the facility, risks, and O&M limit level that is an allowable lower limit of the functions of the facility (MAFF, 2015).

3-1-2 Irrigation Asset Management Cycle

The IAM is composed of the following activities:

(i) Regular O&M including monitoring;
(ii) Periodical function diagnosis;
(iii) Deterioration prediction;
(iv) Scenario and life-cycle cost analysis of conserving functions;
(v) Repair, reinforce, rehabilitate or renew facility.

The obtained data such as the results of function diagnosis and the details of repair, reinforce, rehabilitate or renew facility are stored and accumulated in a digitalized database.

The scenario analysis and life-cycle cost analysis are not included in the scope of this guidance because they are advanced but complicated activities and require cost, time and more proficient skills. Rather, it is more important to build knowledge and experience on periodical function diagnosis with the digital database as a first step of the IAM.

The IAM cycle for irrigation facilities is shown in Figure 7.

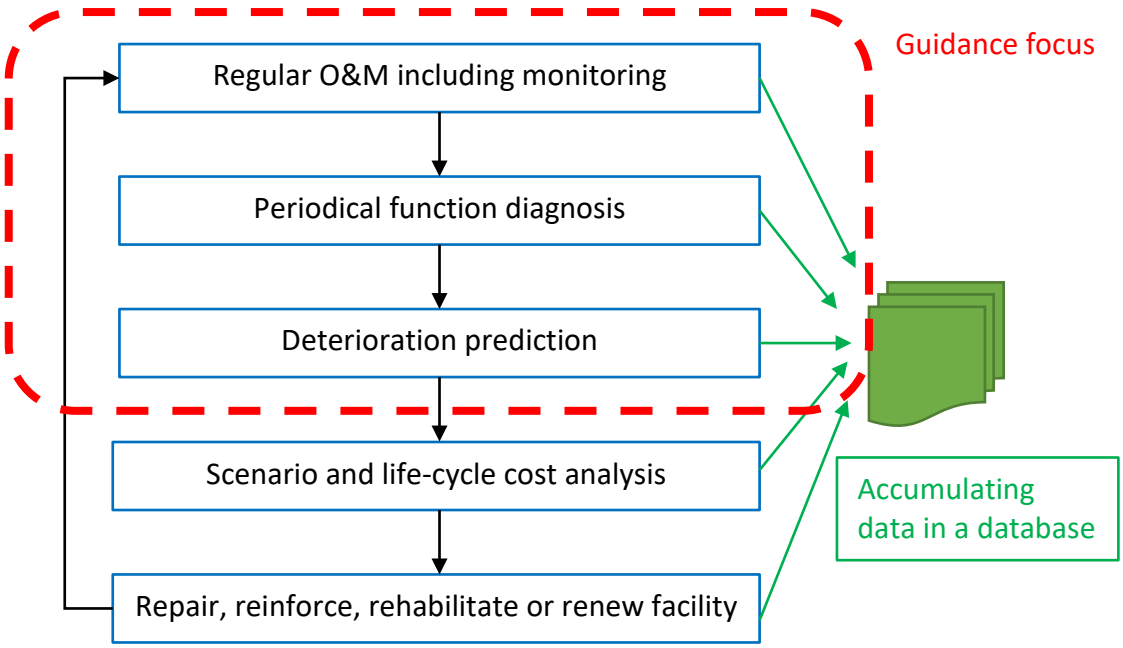


Figure 7. IAM cycle for irrigation facilities

Regular O&M is a good opportunity to know deterioration level and progress status of irrigation facilities and any damage due to natural disasters as well as maintaining good conditions of the facilities. Therefore, it is required to record properly results of the regular O&M (MAFF, 2015).

Function diagnosis is conducted periodically to survey functions and deterioration level of irrigation facilities and to consider optimal actions based on the results of the survey. In principle, engineers conduct function diagnosis on-site by visual checking and/or measuring considering setting fixed points of the survey. In cases where a normal survey for the function diagnosis is not enough for judgement, a more detailed survey should be conducted accordingly (MAFF, 2015).

It is important to record the results of the function diagnosis in the database even if the results show that there is no need for any immediate action for maintaining the function of the irrigation facility. Continuous monitoring of the irrigation facility that seems to be unnecessary for any immediate action is also an important process in the IAM. Through the continuous monitoring and recording its results in the database, it is expected to follow up the progress status of deterioration and improve the precision of deterioration prediction (MAFF, 2015).

3-1-3 Soundness Indicators

In the IAM, Soundness Indicators are used to show deterioration levels and conditions of irrigation facilities. The irrigation facilities (or parts of irrigation facility that has a big and complicated structures) are judged which Soundness Indicator should be applied based on the results of the function diagnosis. In addition, the management level of an irrigation facility can be set by the Soundness Indicators (MAFF, 2015).

The Soundness Indicators, its conditions of irrigation facility and required action are shown in Table 1.

Table 1. Soundness Indicators, its conditions of irrigation facility and required action

Soundness Indicators	Conditions of irrigation facility		Required action
S-5	Sound	Almost no signs of deterioration.	No required action
S-4	Light signs of deterioration	There are light signs of deterioration, but no problem on performing functions.	Continuous monitoring
S-3	Significant signs of deterioration	If deteriorations are left, it is highly likely to have problem on performing functions.	Repair and/or reinforce
S-2	Significant deterioration that affects to structural stability of facility	Having problem with performing functions. Conditions require immediate action.	Immediate repair and/or reinforce
S-1	Multiple critical deteriorations affect to structural stability of facility	High risk of losing functions soon or in the near future. Repairing or reinforcing is not efficient/effective anymore.	Renew/Replace

3-1-4 Function Management

It is required in the IAM to set management levels considering the importance and the risks of individual facilities which indicate to what extent users or operators of the irrigation facility can accept its lowered functions. The Figure 8 shows an image of maintaining functions of irrigation facility using the Soundness Indicators.

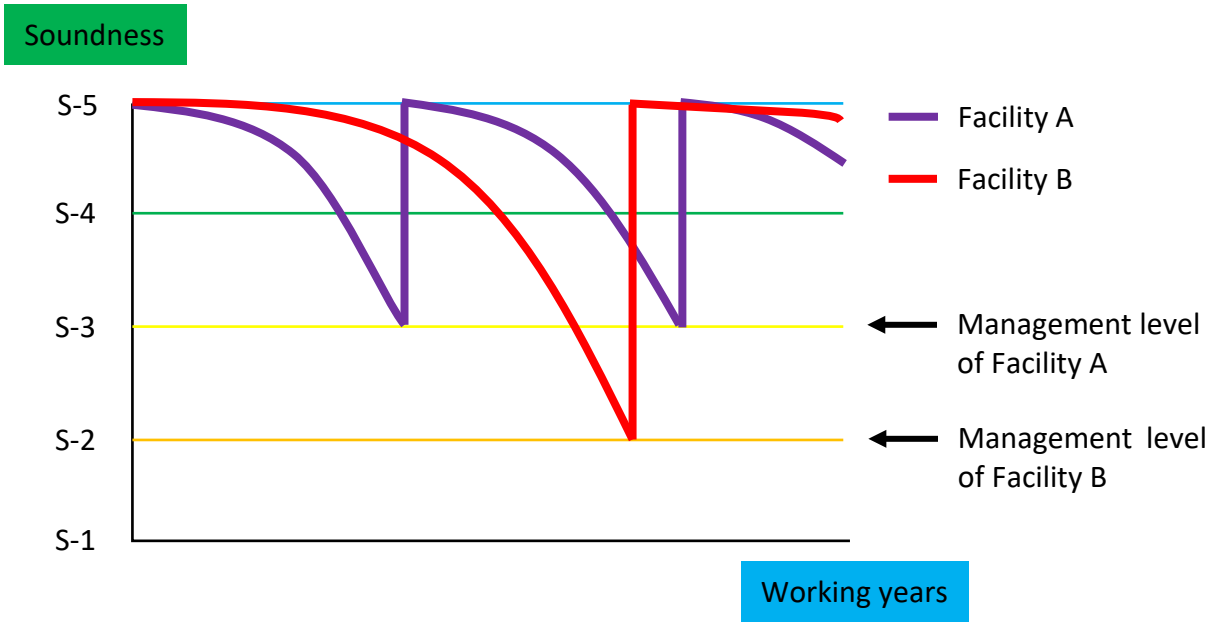


Figure 8. Image of conserving functions of irrigation facility using the Soundness Indicators

3-1-5 Importance Assessment

Individual irrigation facilities are assessed for their importance from a risk management point of view in order to conduct efficiently each process of the IAM. The importance of an irrigation facility should be assessed considering both impacts on agricultural production and besides agriculture (MAFF, 2015).

For the impacts on agricultural production, negative effects to agricultural production and difficulty of restoration (cost and duration) are to be considered when the irrigation facility loses its function or encounters a severe accident.

For other impacts besides agricultural production, the amount of damage is to be considered taking into account neighboring circumstances such as houses and public facilities. For example, the following cases are to be considered as very important facilities where:

(i) the effects to human lives and/or assets are severe since main roads, railway and/or many houses are located around the facility;
(ii) it is concerned to have severe effects on evacuation or rescue activities at the time of natural disaster; and/or
(iii) a severe accident at the irrigation facility significantly affects to local economy and people's livelihoods (MAFF, 2015).

The importance of an irrigation facility can be rated into three categories (Table 2).

Table 2. Importance rating

Importance rating	Meaning of rating
A	Very important
B	Moderately important
C	Low important

Figure 9 shows an example of importance assessment on an irrigation system.

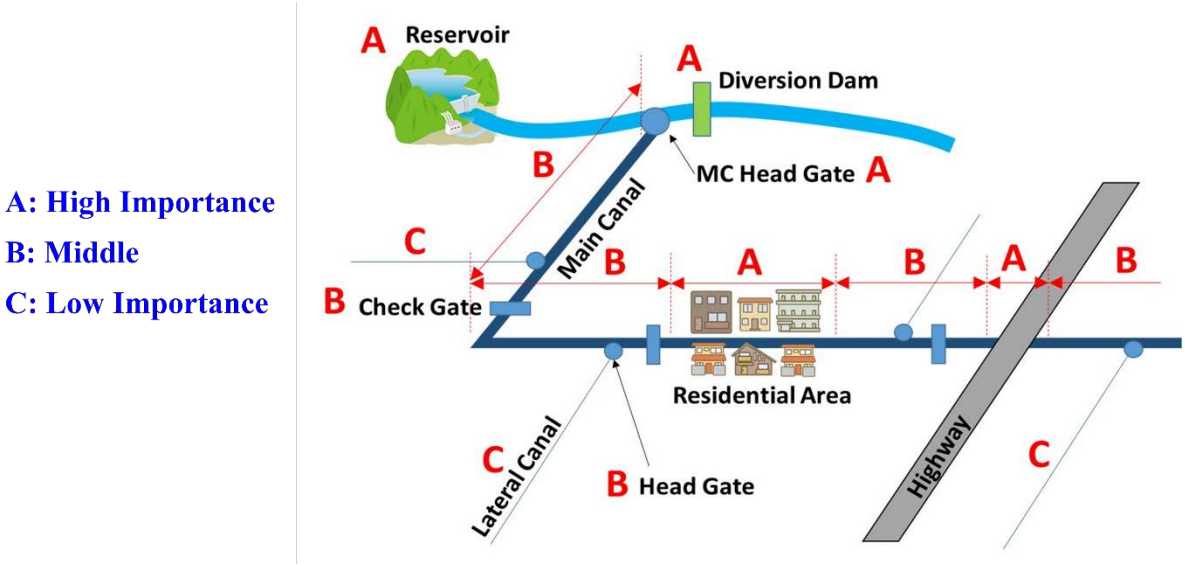


Figure 9. An Example of importance assessment on an irrigation system

Source: ADCA, 2022b

3-1-6 Risk Management

For irrigation facilities, risks such as its service suspension and negative effect or damage to surrounding area are assumed due to deterioration of the facilities and natural disasters. Thus, risk management is important in the IAM by assessing the risks and setting appropriate management level for each irrigation facility. It is also important to note that risks on individual irrigation facilities are different according to its importance, location, surrounding environment and impacts on agriculture and local economy (MAFF, 2015).

The importance rating can be used when consider the management level of an irrigation facility, frequency of conducting the function diagnosis, priorities of irrigation facilities for repair and preliminary measures in advance in preparation of emergency (MAFF, 2015). For example, an irrigation facility with the importance rating A may be set at a higher management level such as S-3 so that we can take preventive measures at earlier stage of deterioration. On the other hand, we may be able to accept the risks for facility with the lower importance rating, which means setting the management level at S-1.

In general, it is a trade-off between acceptance of a risk and the cost of preparation for the risk. Thus, it is important to build a consensus on risk management within an organization that is responsible for management of the irrigation facilities.

Figure 10 shows relations between soundness, importance and risks.

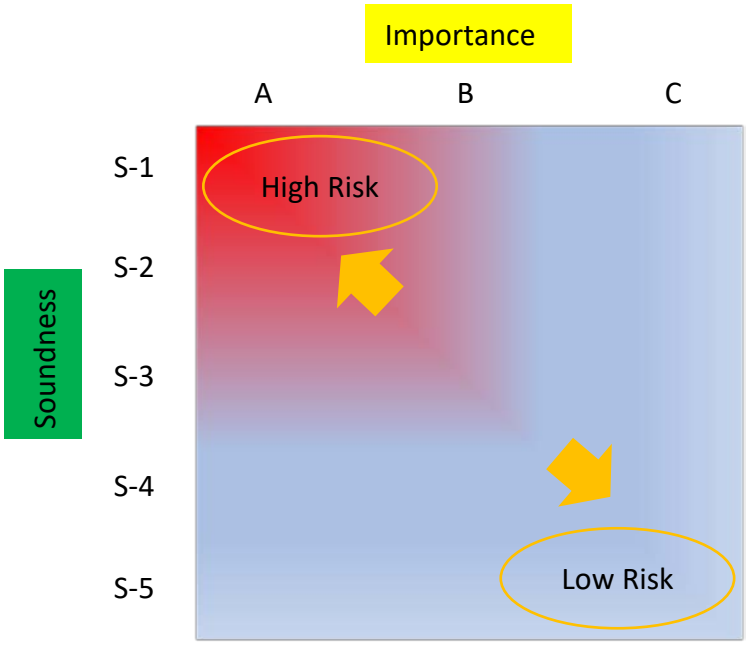


Figure 10. Relations between soundness, importance and risks (MAFF, 2015)

It is a principle that we should take preventive measures for important irrigation facilities so that these facilities will never lose their core functions. However, in practical, it is impossible to avoid all accidents because of constraints of budget, human resources and natural disasters (MAFF, 2015).

Therefore, preparing a Business Continuity Plan (BCP) for important irrigation facilities is one of the important risk management activities. The BCP stipulates, in case of emergency, how to keep irrigation service to the beneficiaries and minimize damage to the people, environment and local economy considering in advance including: how to organize an emergency task force team, who is the decision maker, how to gather information efficiently, what alternative measures are to be taken, who and how will take emergency actions and assistance, how to procure materials and human power for recovering, where is the budget source, how to do public relations and how to train staff.

On another note, considering possible negative impacts on irrigation facilities due to climate change would be also an important perspective of the risk management in the IAM. To take countermeasures in advance such as upgrading irrigation facilities predicting the negative impacts by climate change can reduce the risk of natural disasters and make the irrigation facilities more resilient.

3-2 Regular O&M Including Monitoring

The operator and administrator of irrigation facilities must always take care of maintaining good conditions of the facilities through the regular O&M. Regular site inspection on the facilities and surroundings, and small repairs of the facilities during the regular O&M directly affect to the working life as well as reliability and safety of the facilities (MAFF, 2015).

In particular, there is a case for equipment and machines such as pump station and gate where all functions of the facility are lost even if only a part of the equipment and machine is unfunctional. Hence, there is a need to properly check and maintain the functions according to the kinds and attributes of the facilities. In addition, it should be noted that maintaining the functions can be difficult due to lack or termination of supply for related parts of the facilities (MAFF, 2015).

During regular O&M and monitoring, if the operator or administrator find any sign of significant deterioration or structural change which can affect to loss of its function of the facility, they should immediately report and share the information to responsible institution for the facility. The responsible institution should take prompt actions such as emergent function diagnosis and repairment. It is also important to set some fixed observation points when conducting regular O&M and monitoring of the facilities (MAFF, 2015).

Data on regular O&M and monitoring such as water level, amount of water, operation record of pump and gate, O&M record are important information for function diagnosis, earlier detection of any changes, next O&M and monitoring. Hence, it is important to record the data properly. Further, after natural disasters such as flooding and earthquake, the operator or administrator should monitor the status and conditions of facilities as soon as possible and record the results properly (MAFF, 2015).

During the O&M, the operator or administrator should pay attention to the following points (MAFF, 2015):

(i) structural changes such as distortion, subsidence, rusting, abnormal sound/smell;
(ii) water flow including water level, flow velocity, water hammer, cavitation;
(iii) surrounding environment; and
(iv) claim from users or surrounding residents.

3-3 Function Diagnosis

In principle, function diagnosis is conducted in three stages: (I) gathering information; (ii) overall observation; and (iii) point survey. On conducting function diagnosis, it is desirable to grasp the status and conditions of surrounding environment such as slope, bank and ground that can affect to irrigation facility (MAFF, 2015).

Flow of function diagnosis is shown in Figure 11.

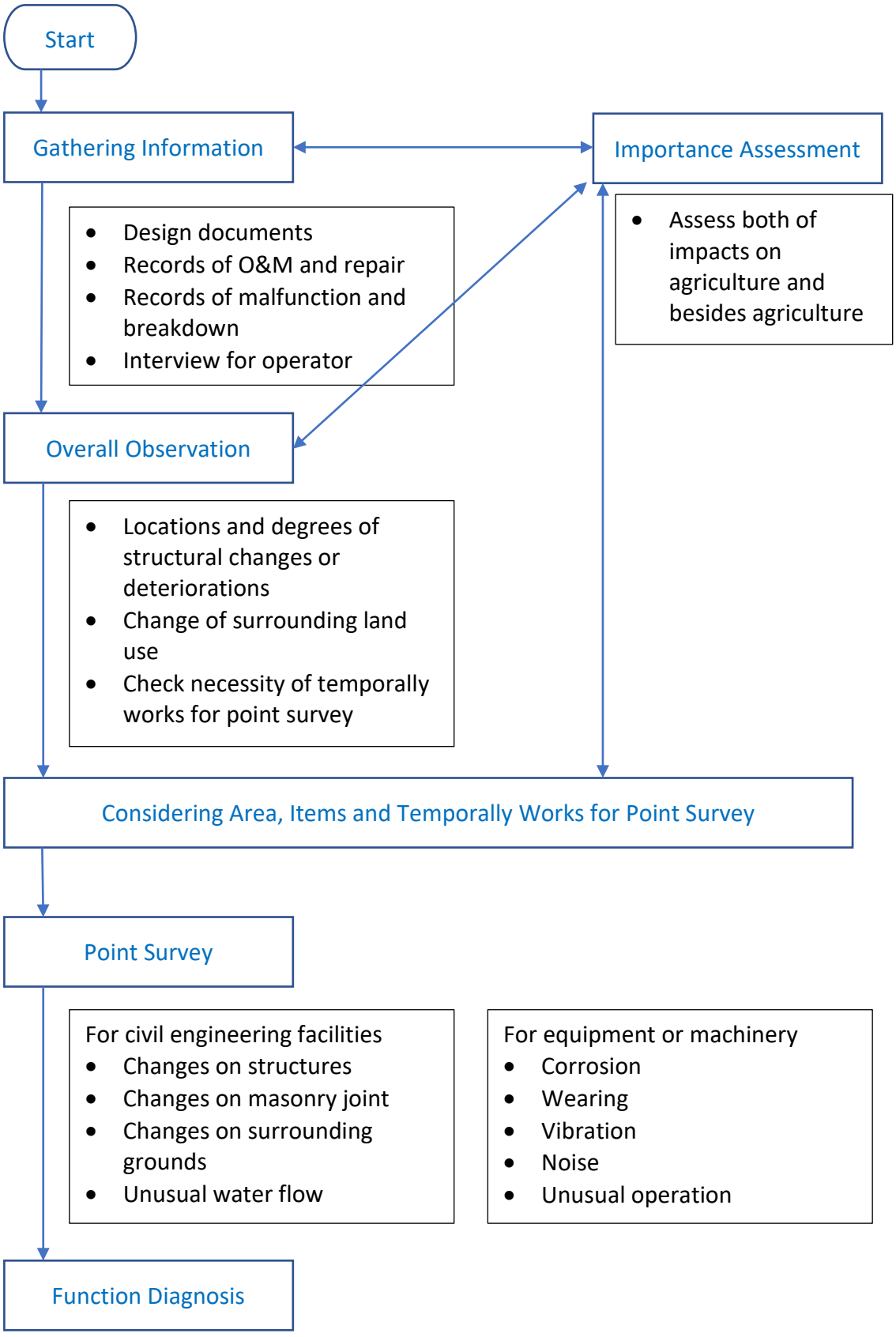


Figure 11. Flow of function diagnosis

Source: MAFF, 2015

Advanced technologies such as remote sensing, unmanned aerial vehicle (UAV), and artificial intelligence (AI) could be used in the function diagnosis and make it more efficient and cost effective. In some countries such as Japan, some advanced technologies including image diagnosis of irrigation facilities using AI and survey of water use in a whole irrigation scheme using satellite data are under development. It is expected that these advanced technologies be adapted for the IAM in a flexible manner.

3-3-1 Gathering Information

At first, basic information to diagnose the function of irrigation facilities is to be gathered through referring to design documents when they were constructed, records and/or database of O&M, repair and malfunction, and interview for operator (MAFF, 2015).

3-3-2 Overall Observation

Overall observation is to conduct visual checking not only for a few irrigation facilities but also the whole irrigation scheme. Through the overall observation, we are to broadly grasp locations and degrees of structural changes or deteriorations in the irrigation scheme. Based on the results of the overall observation, we will consider the details of point survey such as specific locations and items to be surveyed. It is desirable that the operators of irrigation facilities be accompanied during the overall observation because they have a lot of information on changes of the irrigation scheme through their regular O&M (MAFF, 2015).

“Fixed points” for point survey are set based on the results of overall observation. The fixed points are used as specific points of individual irrigation facilities for continuous function diagnosis and monitoring. In principle, the fixed points are set at both points that represent (i.e. deterioration level is default) in the same hydraulic and structural unit and that have significant changes. In case that the function diagnosis was conducted in the past, the fixed points at that time should be continuously used for analyzing changes over time. If any points that have significant changes are found, the points should be included in the survey points (MAFF, 2015).

3-3-3 Point Survey

Based on the results of gathered information and overall observation, point survey is conducted in specific points in the irrigation scheme by close visual checking, measuring, and testing. It is desirable that point survey be conducted in dry condition as much as possible (MAFF, 2015).

Standard survey items for concrete structures and equipment/machinery are shown in Table 3 and Table 4.

Table 3. Standard survey items for concrete structures

Category	Survey item	Survey method
Crack	Maximum width[1]	Measuring
	Length	Measuring
	Crack type	Judging crack type
Material deterioration	Floating	Visual checking, hammering test
	Flaking	Visual checking, measuring
	Pop out	Visual checking
	Efflorescence	Visual checking
	Rust juice	Visual checking
	Change in color	Visual checking
	Wear/Weathering	Visual checking, measuring
	Water leakage	Visual checking
	Exposed rebar	Visual checking
Deformation, distortion	Deformation, distortion	Visual checking, measuring
Compressive strength	Compressive strength	Gauging
Carbonation	Carbonation depth	Drilling
	Concrete cover thickness	Measuring
Masonry joint deterioration	Widening	Visual checking, measuring
	Stepping	Visual checking, measuring
	Water barrier	Visual checking
	Traces of water leakage	Visual checking
	Breaks of surrounding concrete	Visual checking, measuring
Ground deformation	Hollowing of back filling	Visual checking, hammering test
	Differential settlement	Visual checking, measuring

Source: MAFF, 2015

[1] When crack width is over 1.0 mm, there is a probability that corrosion of rebar rapidly progress (MAFF, 2015).

Table 4. Standard survey items for equipment/machinery

Survey item	Survey parts	Survey method
Cleaning up	Gate body, door stop, gate hoisting device	Visual checking
Status of coating[2]	Skin plate, girder, door stop, gate hoisting device, gate control panel	Visual checking, measuring
Deformation, damage, bend	Gate body, door stop, gate hoisting device	Visual checking, measuring
Leaning	Gate body	Visual checking, measuring
Water leakage	Gate body, door stop	Visual checking
Wear	Gate body, door stop, gate hoisting device	Visual checking, measuring
Loose bolt, weld zone breakage	Joint parts, gate control panel	Visual checking, hammering test
Vibration, abnormal noise, hearing	Gate body, gate hoisting device	Visual checking, measuring
Oil leakage	Gate body, gate hoisting device	Visual checking, weighing
Operation confirmation	Gate body, gate hoisting device, gate control panel	Visual checking, operation checking by manual
Spares	Gate hoisting device, gate control panel	Visual checking
Damage, breakage, dirt	Gate control panel	Visual checking

Source: MAFF, 2015

3-3-4 Frequency of Function Diagnosis

The frequency of the function diagnosis should be decided considering the soundness indicator and the importance rating. Even though deterioration is not yet progressing much, conducting the function diagnosis periodically is necessary to gather information of the deterioration process until then and predict the deterioration process hereafter (MAFF, 2015).

The Table 5 shows an example of the frequency of function diagnosis.

[2] When deterioration of coating is seen over 20% of total area, the soundness level should be judged S-3 or S-2 (MAFF, 2010).

Table 5. An example of frequency of function diagnosis

Soundness indicator	Frequency of function diagnosis
S-2	3-5 years
S-3	5 years
S-4, S-5	10 years

Source: MAFF, 2015

3-3-5 Judgement of Soundness Level

The soundness level is judged by the Soundness Indicators (Table 1) based on the results of the function diagnosis. In case that one facility is shown multiple soundness indicators, for example, one part is S-3 and another part is S-2, the stricter soundness indicator should be adopted (in the example, S-2 should be the soundness level of this facility) (MAFF, 2015).

The skills of engineering judgement of the soundness level for an engineer and an organization will be improved by accumulating experience on the function diagnosis. It is effective and important for discussion and validation on the judgement in the organization to record the reason why this soundness level in question is adopted. An IAM database, ADCA System, makes it possible to record the reason for the engineering judgement as a memo. It is to be desired that any judgement criteria of the soundness level be developed according to the development levels of irrigation schemes and facilities through recording and verifying the judgement of the soundness level repeatedly and over time. For reference, a standard criteria in Japan for the judgement of the soundness level for reinforced concrete lining water canal is attached to the ANNEX III.

The Department of Irrigation (DOI) under the Ministry of Agriculture and Forestry (MAF) of Lao PDR implemented a pilot testing in 2023 on the IAM referring to a draft version of the MRC IAM Guidance. The DOI conducted the function diagnosis for irrigation facilities of the KM.35 Project area in Savannakhet Province. Some results of the function diagnosis are attached to the ANNEX IV.

3-4 IAM Database

In the IAM, on-site data acquired from the regular O&M, monitoring and function diagnosis are important basic information. Continuous observations on structural and functional changes of irrigation facilities are required, which will be basic data for appropriate function diagnosis (MAFF, 2015).

However, in many cases, these basic data are not collected properly and stored paper base, which makes it difficult to use the data (MAFF, 2015).

Thus, development of an IAM database that stores the IAM information such as function diagnosis, regular O&M and repair history, and that is easy to update and find the information is very important. The IAM database enables the government officers and engineers to use the IAM information in various cases not only for the regular O&M, but also improving for more precise function diagnosis in consideration of the measures and the actions for deteriorated facilities, and to take prompt actions at the time of natural disaster or sudden accident (MAFF, 2015).

The Agricultural Development Consultants Association (ADCA) of Japan has developed an advanced and simple IAM database “ADCA System” (Figure 12 and Figure 13). The ADCA System is license-free software and can be operated and accessible by a smartphone and maintained at low cost. The outline of the ADCA System is attached to ANNEX I.

To access the ADCA System, the internet access is required. However, sometimes, there could be no internet access in remote areas particularly where the irrigation schemes are located. Under such conditions, it seems to be a solution that a staff records the site locations of the function diagnosis using a GIS map like the Google Map off-line and inputs the data in the ADCA System when going back to the office. The function of the Global Positioning System (GPS) can be used off-line even without the internet access.

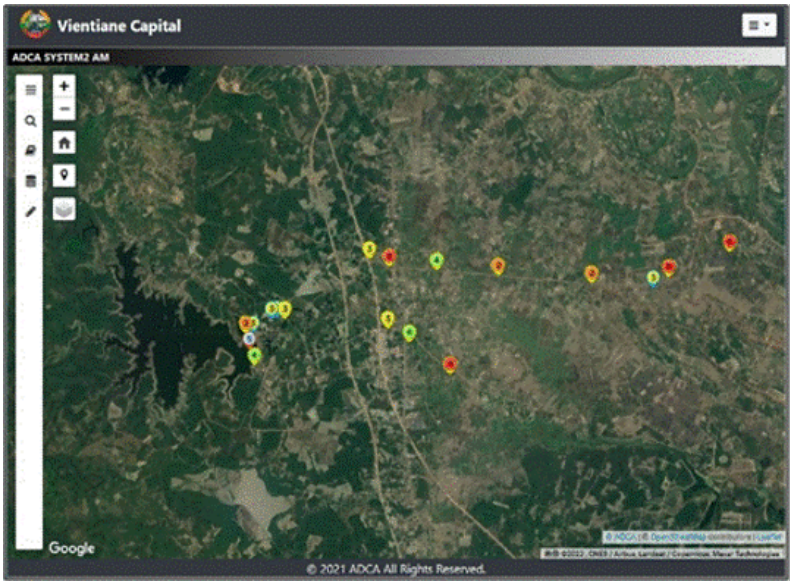


Figure 12. IAM map on ADCA System

Source: ADCA, 2022a

Figure 13. IAM data on ADCA System

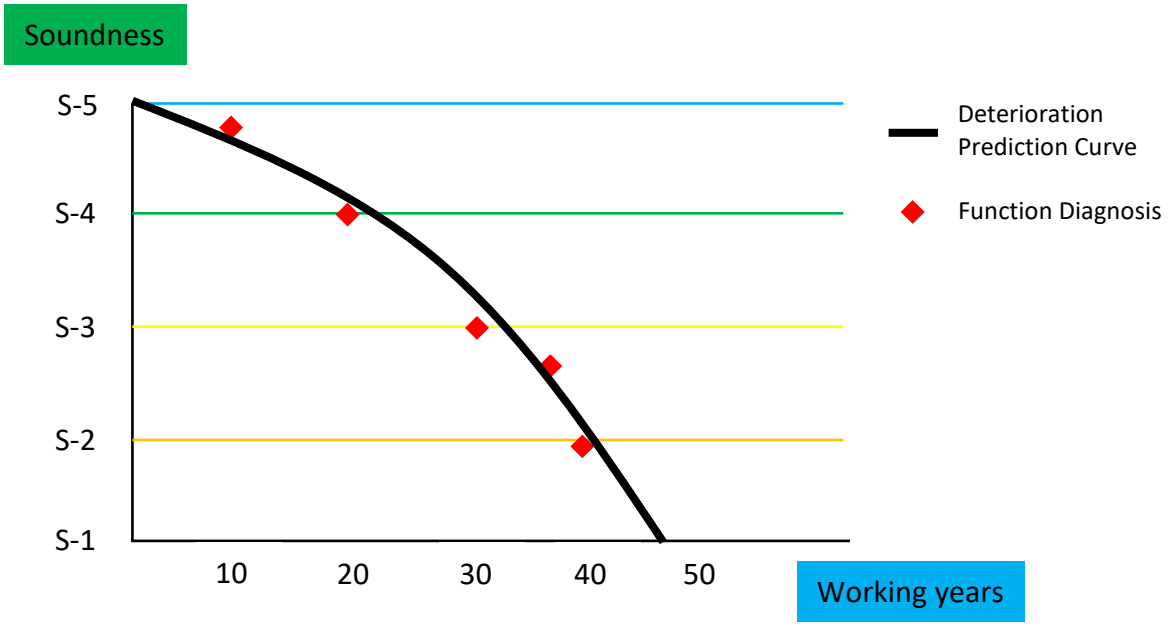
Source: ADCA, 2022a

3-5 Deterioration Prediction

The IAM makes it possible to predict future progress of deterioration for an irrigation facility by accumulating the function diagnosis.

The Figure 14 shows an example of a deterioration prediction curve of an irrigation facility calculated on results of the function diagnosis.

It is important to grasp a deterioration trend of the individual irrigation facility through continuous function diagnosis because progress of the deterioration is different in each irrigation facility according to conditions such as climate conditions, frequency of maintenance, volume and velocity of water flow, which brings further improvement of the deterioration prediction to be more precise. It is to be noted that actual deterioration prediction curve cannot be shown on a single curve, rather, has some fluctuation due to the different conditions in each irrigation facility (MAFF, 2015).



4 CONSIDERING GENDER APPROACHES IN IRRIGATION ASSET MANAGEMENT

The daily base O&M such as removing sediment and weeding in a water canal plays an important role in the IAM.

However, given a large number of stocks of irrigation facilities in the Member Countries, it is impractical that the public sector is responsible for the O&M of all irrigation facilities. The cooperation with farmers, communities and water user groups is essential.

In particular, it is generally common that the farmers and the communities are responsible for the O&M on the field level irrigation facilities because they are close to the farmers' field plots and closely related to the field level water management. It is necessary and effective that the field level O&M be conducted with the participation of women. Due to the women participation in the field level O&M, we are capable of getting wider and more useful information and opinions from the end-users from the gender point of view such as an idea of water canal structures for easier O&M, location and structures of intake outlets for more efficient intake of water, and how to distribute water in a fairer manner.

The women participation in the IAM is expected to give a lot of policy implications on improving the irrigation facilities and on considering the more efficient O&M. In addition, the women participation would contribute to making the working life of irrigation facilities longer through more frequent and detailed O&M.

Integrating gender-sensitive approaches to irrigation technology dissemination can facilitate wider adoption of these technologies, leading to improved agricultural livelihoods, improved food and nutrition security, increased climate resilience, and women's empowerment (Bryan, E., & Didi, E. H., 2019).

5 RECOMMENDATIONS

This guidance explains the basic concept and methodology of the IAM for irrigation facilities.

When the IAM for irrigation facilities is applied practically, it is desirable that each Member Country improve and customize this guidance reflecting and incorporating individual status and conditions on irrigation schemes in a country taking the scale and types into consideration through accumulating knowledge and experience on the IAM. In that sense, this guidance is a living document that is to be continuously revised and improved.

In particular, it is difficult to develop a common standard or criteria on judging the soundness levels in the function diagnosis of irrigation facilities because natural environments, status of irrigation scheme development and usage, quality of irrigation facilities, and allowable risks in case of loss or lowered functions of irrigation facilities are different in each Member Country.

When improving the exactness of judging the soundness levels in the function diagnosis and developing judging criteria of the soundness levels in a country, the IAM database such as the ADCA System would be a great help.

Recording and storing the past results of function diagnosis and soundness levels of an irrigation facility in the IAM database enables to verify if the reason of the judgement of the soundness level was reasonable or not by comparing the current status of the irrigation facility with the past record of the function diagnosis, which would lead to continuous improvement of the IAM technology. In addition, this accumulation of data and experience on the IAM will be important technical assets for the organization.

Lastly, three specific aspects to be considered when applying for the IAM are highlighted.

The first one is continuous capacity building. The hands-on On-the-Job Training (OJT) is important for irrigation engineers to conduct the regular O&M and the function diagnosis for irrigation facilities making the most of the database application such as the ADCA System. The accumulation of knowledge and experience on individual irrigation engineers would bring improvement of technical expertise in organization, which would make it possible maintaining functions, better performance and longer working life of irrigation schemes in the country.

The second one is preparing effective budget request documents or funding proposal for repair, rehabilitation or improvement for deteriorated irrigation facilities using the results of the IAM and records of the IAM database. The visualization of deteriorated conditions of irrigation facilities and the accumulation of time-series status of deterioration by the IAM make possible the evidence-based budget planning and request for required actions and countermeasures for the deteriorated irrigation facilities. These budget request documents enable the government officials and engineers to explain the rationale of the budget request with clear evidence answering to what is the current status of the deterioration and lowered functions of the irrigation facility, what are the risks of the deteriorated irrigation facility, and what are the measures to prevent further deterioration or recover the lowered functions. Further, when an organization accumulates experience on the IAM, it is possible for the

organization to estimate the required budget to maintain appropriate functions of irrigation facilities for the next five years and leveling the required budget in each year.

The last one is to consider the gender approaches in the IAM. When conducting the overall observation of irrigation scheme and the function diagnosis of irrigation facility, it is recommended actively to collect information and opinions from both male and female water users. The suggestions and findings from various directions would be key information to further improve the irrigation facilities which are more efficient and user friendly. In addition, to ensure women's participation in daily O&M of irrigation facilities is another critical point in order to make the working life of irrigation facilities longer through more frequent and detailed O&M.

It is expected that applying the IAM in the Member Countries bring efficient and proper maintenance of irrigation facilities and attribute to stable agricultural production and ensuring food security.

GLOSSARY

Irrigation Facility Individual irrigation structure or equipment in an irrigation scheme

Irrigation Scheme A whole irrigation system that composed of multiple irrigation facilities

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ANNEX I: OUTLINE OF ADCA SYSTEM AND HOW TO OPERATE

(*Source*: ADCA, 2022b)

1 Characteristics of ADCA System

The ADCA System[3] is an Irrigation Asset Management (IAM) database developed by the Agricultural Development Consultants Association of Japan (ADCA). The ADCA System features the following four characteristics.

(i) Operate with a smartphone
- Able to directly input data on-site by smartphone
- Able to prevent human errors by automatic input of coordinates
- Able to link coordinates to photos taken

(ii) Past data management
- Input data is stored in the database and can be compared with past data.

(iii) Data sharing
- Data can be shared timely and easily among staff and stakeholders.
- Able to easily correct any mistake on data input and to update

(iv) Low software cost
- Built with license-free software
- No copyright fees are required.
- System maintenance cost is low since the software will be installed in its own physical server or in server provided by international cloud service company

2 Architecture[4]

2-1 System Architecture

Client accesses web server from browser of a personal computer or uses a smartphone and inputs and/or outputs data via web application.

The web application processes input data and registers the data in database. If images (photos) or videos are included, they are uploaded to the specified directory.

Text data and image/video data are output from the database via the web application according to the client's request.

[3] As of 25 January 2023, the ADCA System is available in four provinces in Lao PDR and in 13 provinces in Viet Nam.

[4] Computer “architecture” means a set of rules and methods that describe the functionality, organization, and implementation of computer systems.

The architecture image of the ADCA System is shown in Figure 15.

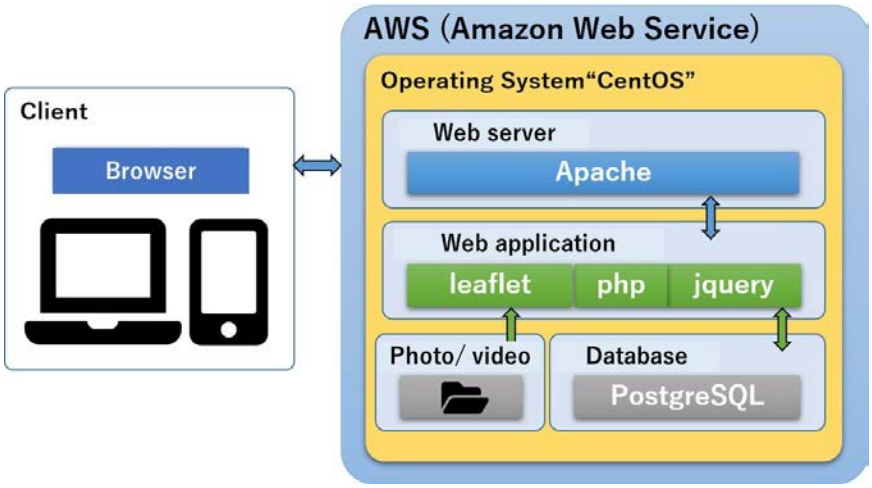


Figure 15. Architecture Image of ADCA System with international cloud service (AWS)

2-2 Data Structure

Input data tables and images are automatically stored in the database. New creation, edition and deletion of data can be done only for current year data. By accumulating the data input process every year, past data are automatically and digitally archived, and the current year's data at a place (point) are easily comparable with the past data.

For example, in the 2020 survey, the initial soundness level of point A was S-1. Repairs were conducted for the point A in 2021. Due to the repairs, the soundness level changed to S-3 and new images of the point A were input in the database. In 2022 survey, there was no change from the previous year for the point A, and soundness level was the same as S-3 with only a new photo input. The survey results in each year were automatically recorded in the database.

For another example, one can compare the total number of points judged as soundness level S-1 in 2021 and in 2022 to confirm and use an evidence that overall soundness of the irrigation system has been improved.

An image of the data structure is shown in Figure 16.

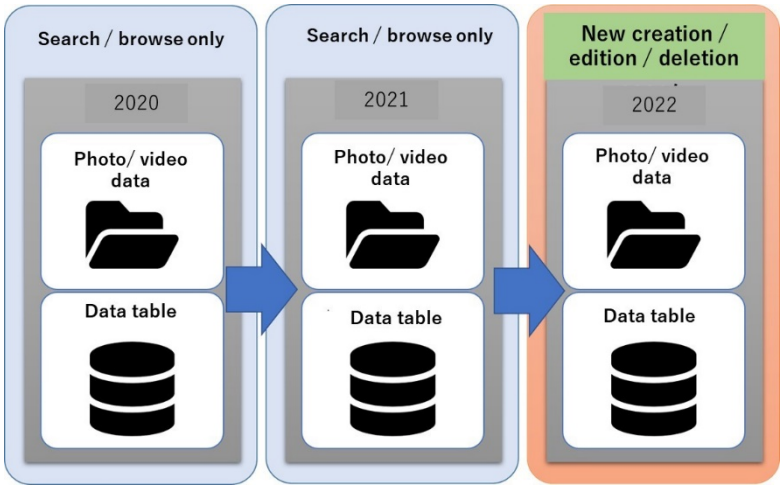


Figure 16. Image of data structure

3 Interface of ADCA System

3-1 Top Page

Users can access to top page of the ADCA System on https://doi.adca-system.org/ (Figure 17).

The pages of the ADCA System are mainly composed of the Geographic Information System (GIS) and designed without horizontal scrolling. In addition, by limiting vertical scrolling as much as possible, stress-free operability is realized on all devices.

Figure 17. Top page of ADCA System

3-2 Base Map

The default base map is the Open Street Map. Users can switch between base maps by clicking the icon in the GIS menu (Figure 18).

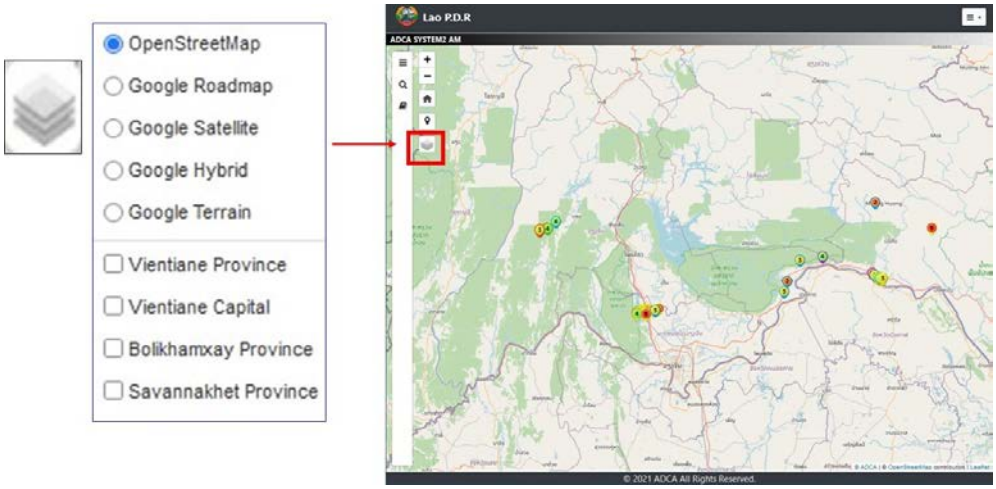


Figure 18. Base map

3-3 Soundness Marker

In the ADCA System, markers indicated on the base map are classified by the five soundness levels from S-1 to S-5 and five types of irrigation facilities (Figure 19).

- **Facility type**: dam, important structure, headworks, left bank of canal and right bank of canal
- **Soundness**: S-1 to S-5, shown as number in the marker
- **Facility color**: dam (red), important structure (yellow), head works (purple), canal left (green) and canal right (blue)
- **Soundness color**: S1 (red), S2 (orange), S3 (yellow), S4 (green) and S5 (blue)

When the marker is clicked, a pop-up is displayed, and the point name, image, and marker menu (view/edit) are also displayed (Figure 20).

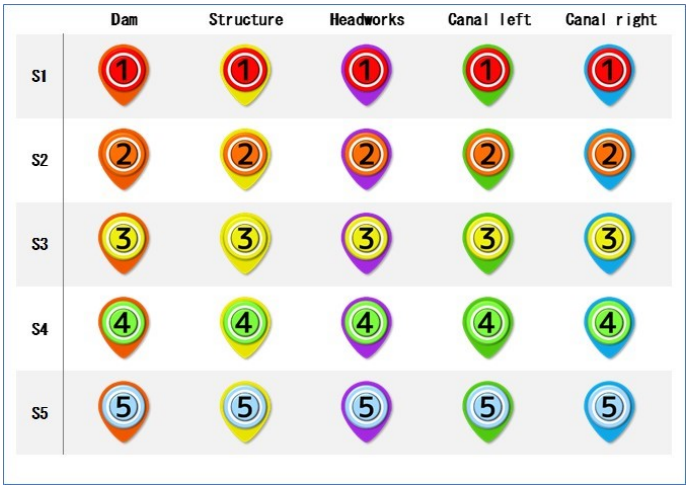


Figure 19. Soundness marker

Marker pop-up

Figure 20. Marker pop-up

3-4 Site Menu

The ADCA System has three site menus, GIS menu, IAM menu and Link menu (Figure 21, Figure 22 and Figure 23).

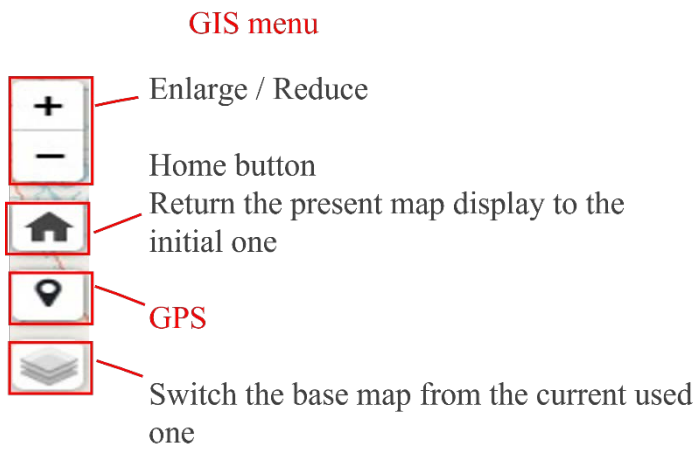


Figure 21. GIS menu

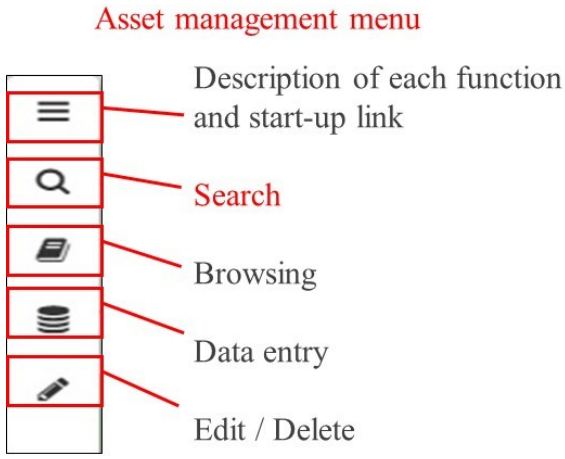


Figure 22. IAM menu

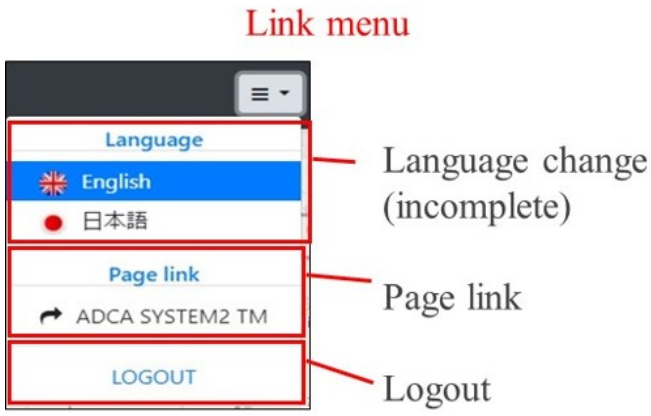


Figure 23. Link menu

3-5 Data Input

To input data into the ADCA System, internet access is necessary. The data input can be done through personal computer, smartphone or tablet.

The processes of data input are following seven steps.

(i) Step 1: Click GPS button from the GIS menu to display the current location on the map (Figure 24).[5]

Figure 24. GPS button

(ii) Step 2: Right-click or long-press the point to be registered on the map to pop-up the temporary marker (Figure 25).

- To register coordinates of the point where the marker appears, confirm if the point is correct by looking at the aerial photograph (changing the base map to "Google Satellite")
- Click "Add to" button from the temporary marker pop-up menu (Figure 26).

[5] This step is not required if the point is known and pre-identified on the map.

Figure 25. Pop-up marker

Figure 26. "Add to" button

(iii) Step 3: The data entry form will open. Then, enter all the required information (Figure 27).

- The input data are "Created date", "Type", "Material", "Soundness", "Importance", "Name" and "Coordinate".
- "Created date", "Name" and "Coordinates" are automatically entered.
- However, "Created date" and "Name" can be corrected and/or renamed freely.

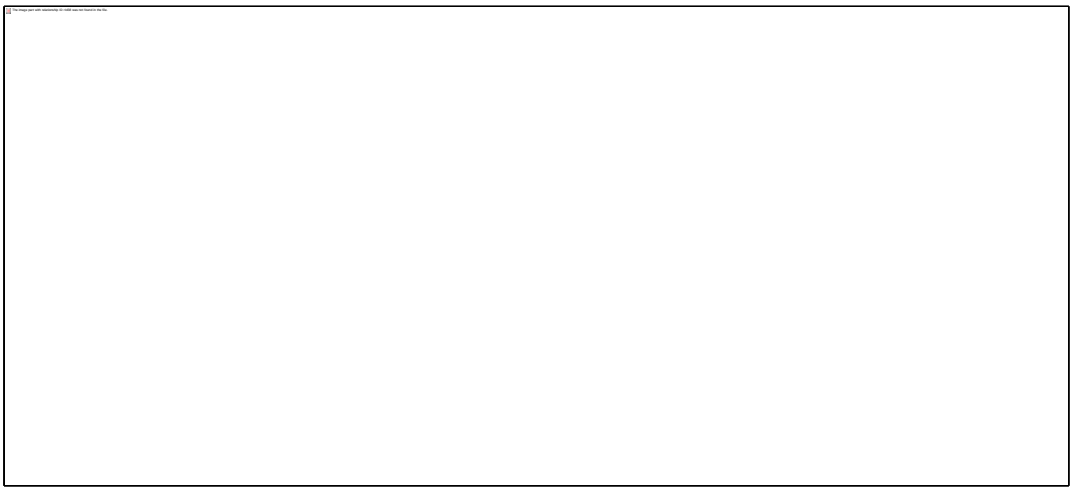


Figure 27. Data entry form

(iv) Step 4: Upload images and/or video files (Figure 28).

- File of image and video can be uploaded for "jpg, jpeg, png and mp4".
- Up to three image files can be uploaded.
- To add/delete an image, click the button on the upload form.
- For video, only one video file can be uploaded within the file size of 20 MB. In case of the video file size over 20 MB, a warning message will be displayed on the screen.

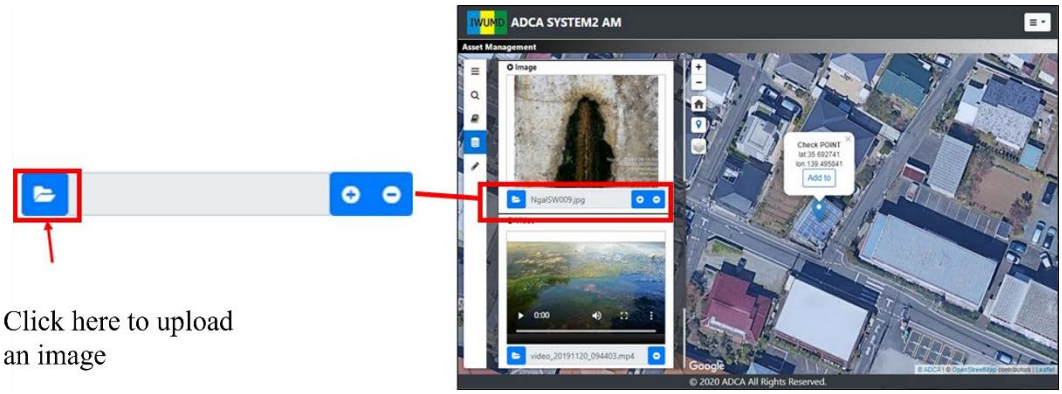


Figure 28. Upload image and video files

(v) Step 5: Input memo (Figure 29).

- Users can input memo in any language for any other information that would be useful as a record of the AM.
- It is desirable that detailed information of conditions and findings on irrigation facility is recorded in the memo.

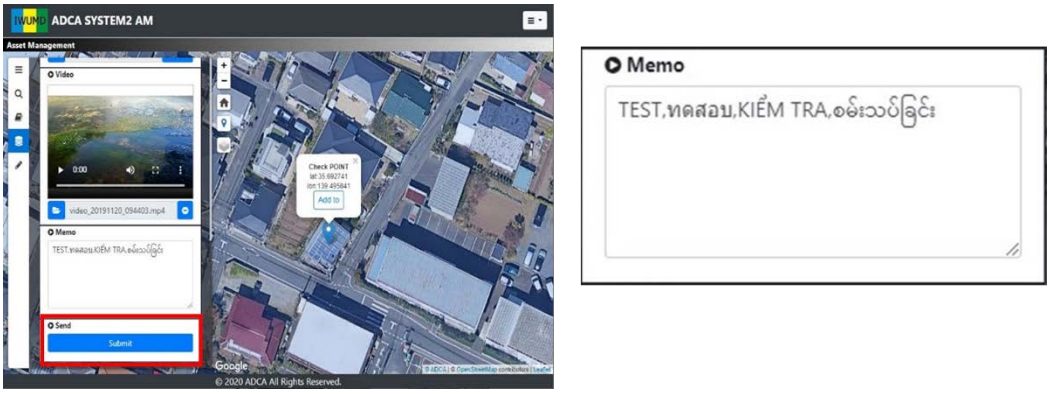


Figure 29. Input memo

(vi) Step 6: Submit (Figure 30).

- When users complete the data entry, the data entry completion screen will be displayed. Once the input data are re-confirmed, click “OK” button (Figure 31).

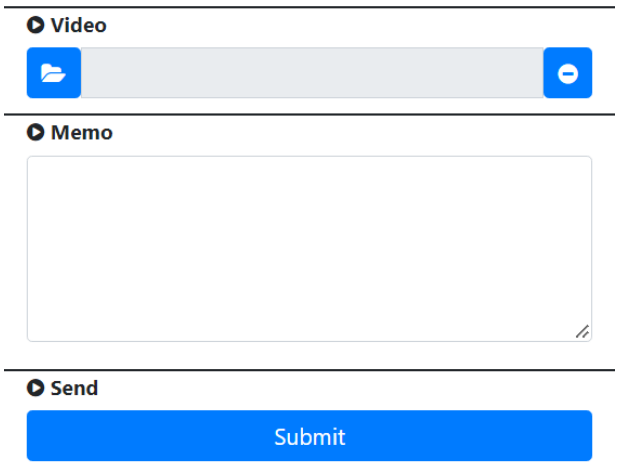


Figure 30. Submit button

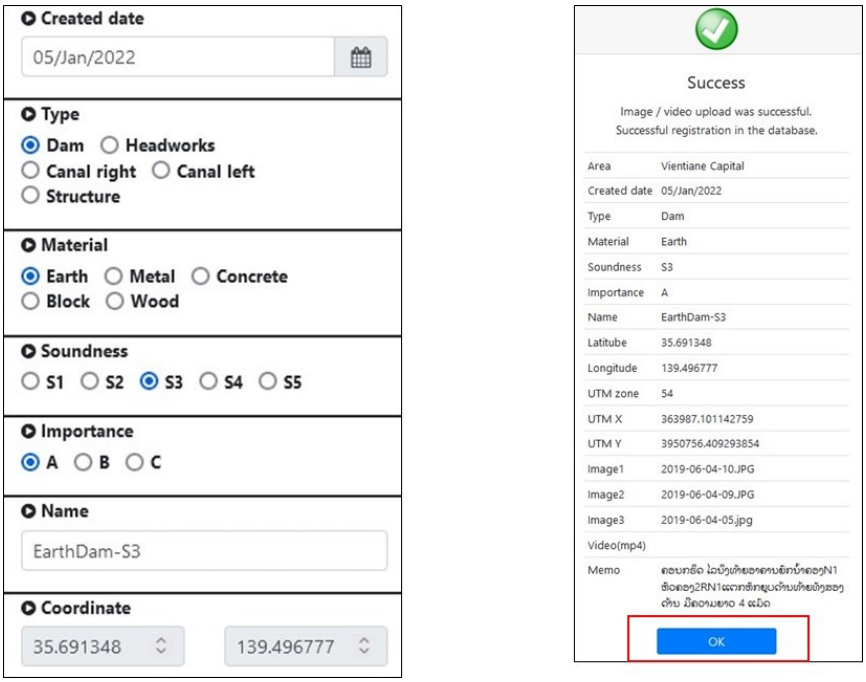


Figure 31. Data entry completion screen

(vii) Step 7: Marker with input data on the map (Figure 32).

- Users can now find the maker with input data on the GIS map.

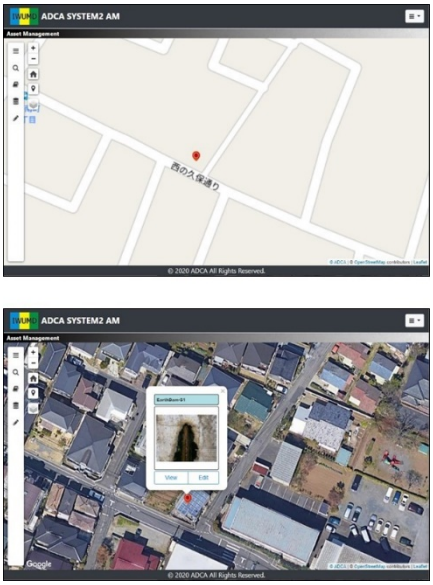


Figure 32. Marker with input data on the map

3-6 Data Browsing

To browse the input data, click a marker on the map or select a marker from the search menu. Then, click “View” button on the marker menu (Figure 33).

Data browsing screen will be shown (Figure 34).

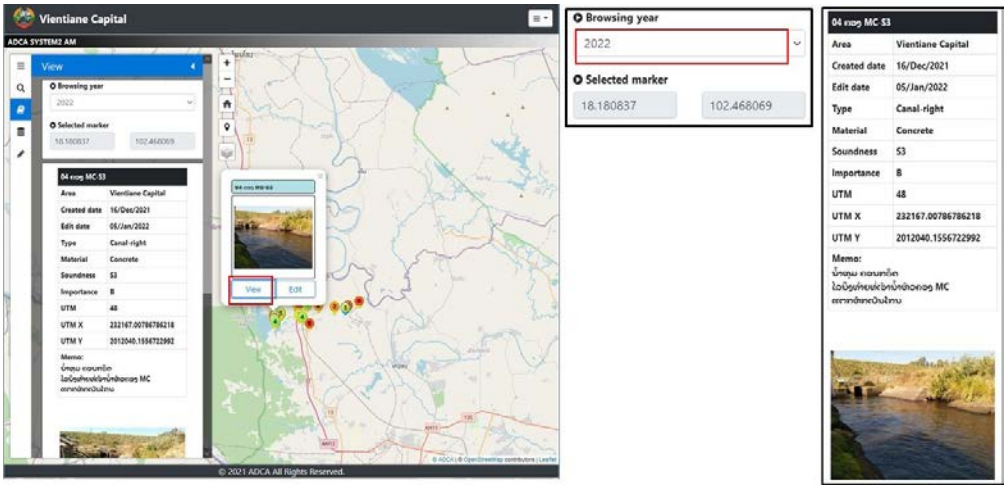


Figure 33. Data browsing

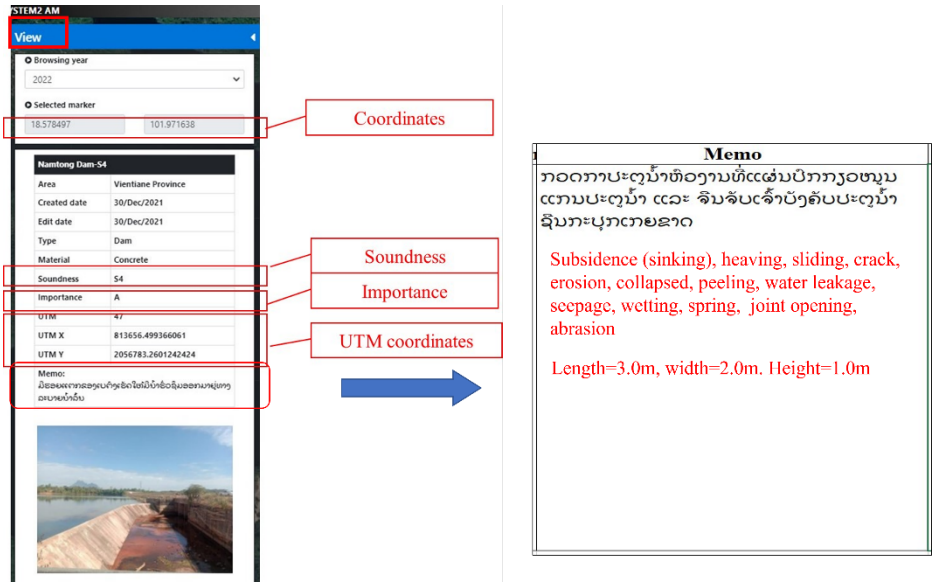


Figure 34. Data browsing screen

3-7 Data Search

To search data, click the “Search” icon. Enter search conditions in search form and click “Search” button (Figure 35).

When click the result table, the targeted marker will be popped-up on the map (Figure 36).

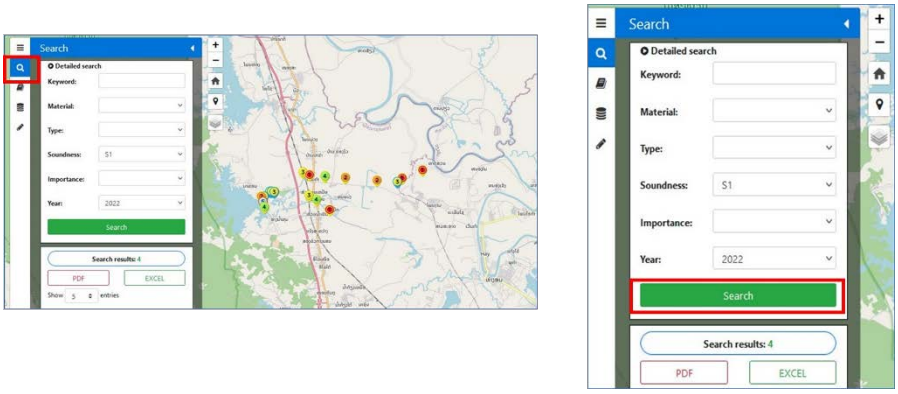


Figure 35. Data search

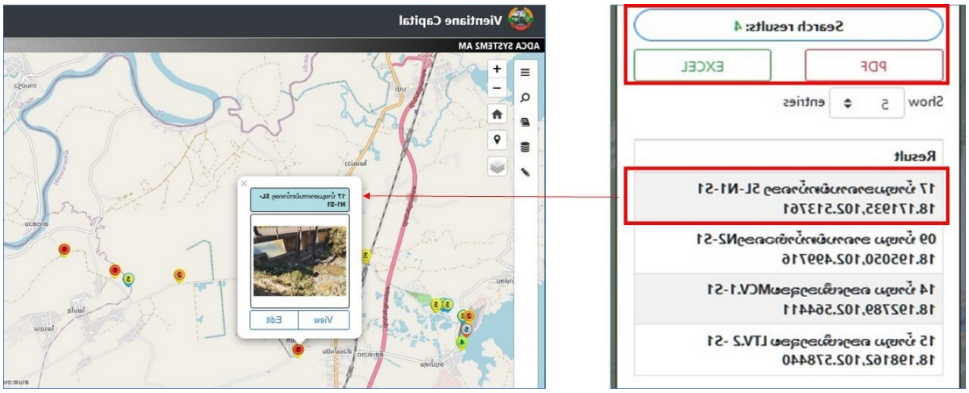


Figure 36. Pop-up targeted marker

3-8 PDF Output

When “PDF” button is clicked on the search result screen, the information of all the points of the search result is downloaded in PDF format (Figure 37).

Regarding the image in the PDF output, only the first image (photo) among maximum three photos is displayed. The memo cell written in local language is output as entered (Figure 38).

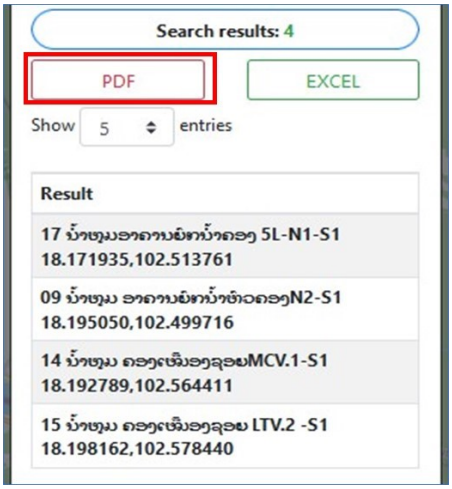


Figure 37. PDF output button

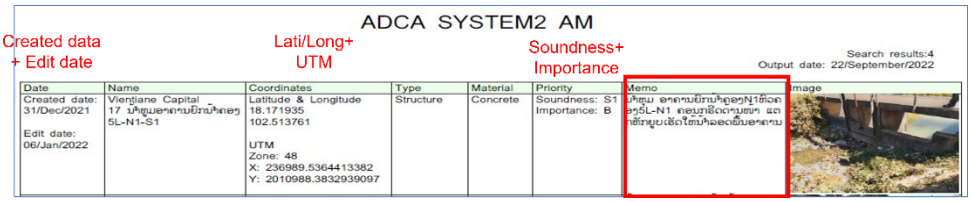


Figure 38. PDF output

3-9 Excel Output

When “EXCEL” button is clicked on the search result screen, the information of all the points of the search result is downloaded in Excel format (Figure 39).

For images, just a name of the image file is output in Excel sheet. Hence, it is necessary to insert the images from image file folder to the Excel sheet (Figure 40).

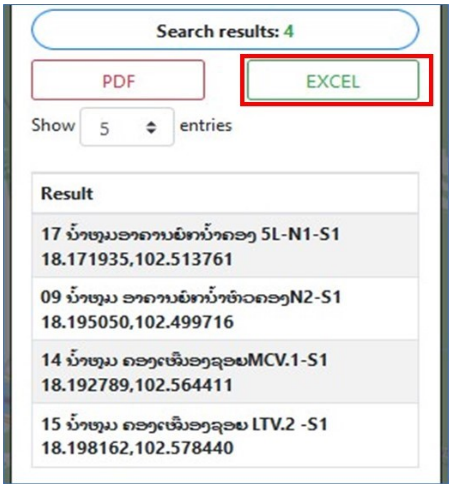


Figure 39. Excel output button

Created date	Edit date	Capital/Province	Name	Latitude	Longitude	UTM zone	UTM X	UTM Y	Type	Material	Soundness	Importance	Memo	Image1	Image2	Image3
28/Dec/2021	28/Dec/2021	Vientiane Capital	EarthStructure-S1	18.198162	102.578440	48	243873.37377784058	2013800.702270486	Structure	Earth	S1	B	ຄອງເໝືອງຊອຍLTV2ຖືກຕົ້ນເຂີນເປັນບ່າບໍ່ສາມາດນຳໃຊ້ໄດ້	181981621025784400.jpg	181981621025784401.jpg	
28/Dec/2021	28/Dec/2021	Vientiane Capital	EarthStructure-S1	18.192789	102.564411	48	242380.91284889425	2013225.4707443	Structure	Earth	S1	B	ຄອງເໝືອງຊອຍMCV1 ຄອງຕົ້ນເຂີນນຳໃຊ້ບໍ່ໄດ້	181927891025644110.jpg	181927891025644111.jpg	
31/Dec/2021	31/Dec/2021	Vientiane Capital	Concrete Structure-S1	18.171935	102.513761	48	236989.5364413382	2010988.3832939097	Structure	Concrete	S1	A	ອາຄານຍົກນ້ຳຄອງN1ຫົວຄອງ5L-N1ເປີດຮົ່ງແຕກຫັກຊຸບເຮັດໃຫ້ນ້ຳລອດພື້ນອາຄານ	181719351025137610.jpg	181719351025137611.jpg	
31/Dec/2021	31/Dec/2021	Vientiane Capital	Concrete Structure-S1	18.195050	102.499716	48	235537.8779956954	2013567.94782825	Structure	Concrete	S1	B	ອາຄານຍົກນ້ຳເຂົ້າຄອງເໝືອງN2ແຕກຫັກຊຸບໝົດ	181950501024997160.jpg	181950501024997161.jpg	

Figure 40. Excel output

3-10 Data Edit

Click the marker to be edited, and click "Edit" on the marker menu. Click the "Edit start" button to open the edit form (Figure 41).

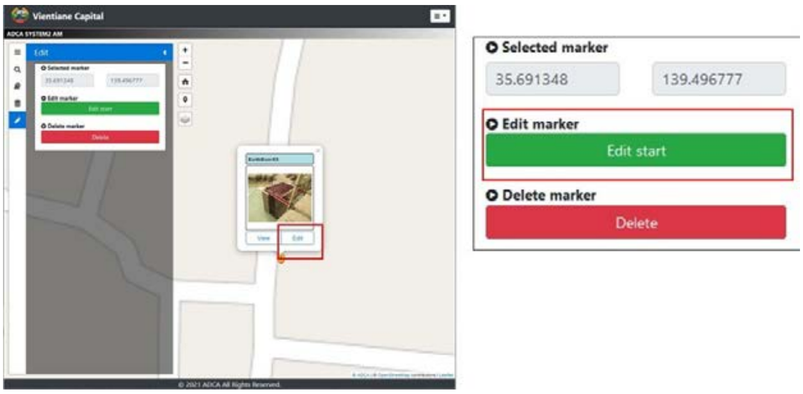


Figure 41. Data edit screen

In the edit form, "Edit data" is registered as the date of the current day and "Created date" is registered as the data entry date. Thus, these date entries cannot be edited. Similarly, the coordinates cannot be edited because the coordinates of the point is fixed at the time of data entry (Figure 42).

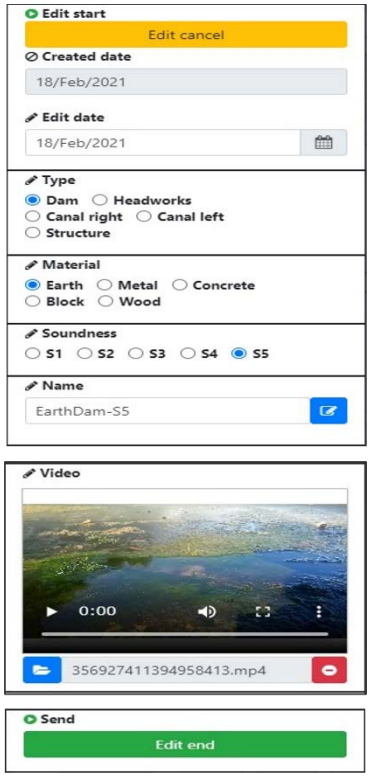


Figure 42. Edit form

When clicked “Edit end” button, the “Confirm edit" screen appears. On the “Confirm edit" screen, the changed part is displayed in red characters. Once edited data are correct, please click the “Yes” button on the “Confirm edit" screen. The "Success" screen appears (Figure 43).

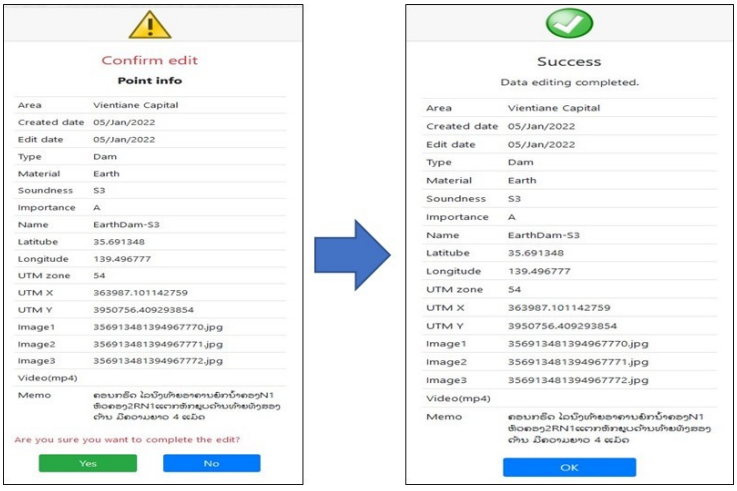


Figure 43. Confirm edit screen

3-11 Data Delete

Click the marker to be deleted, and click “Edit” on the marker menu. Click the “Delete” button (Figure 44).

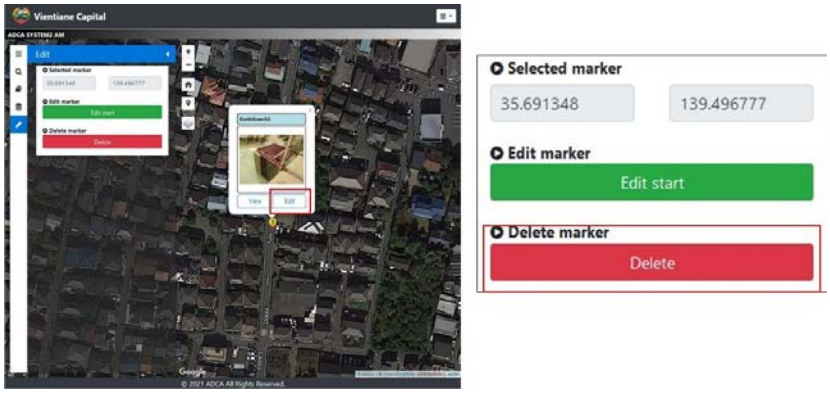


Figure 44. Data delete screen

When clicked “Delete” button, the “Delete all?" screen appears. Checking “Yes, delete it.” box, please click the “Delete” button on the “Delete all?" screen. The "Deleted Successfully." screen appears (Figure 45).

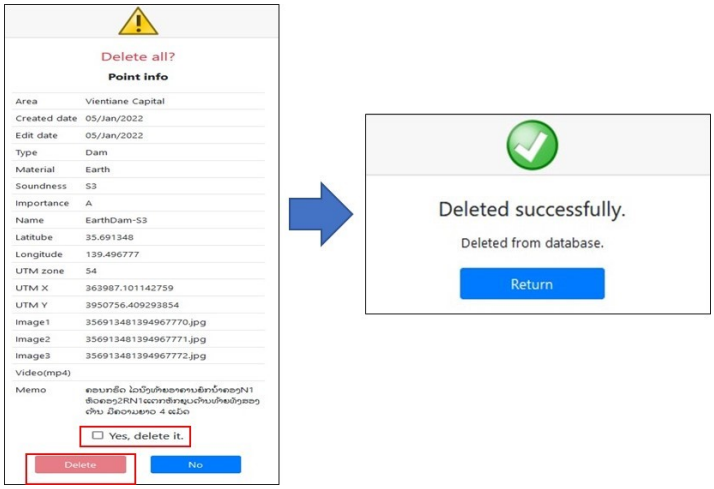


Figure 45. Delete confirmation screen

ANNEX II: SAMPLE PHOTOS OF DETERIORATED IRRIGATION FACILITIES WITH SOUNDNESS LEVEL

(*Source*: ADCA, 2022c)

Earth Dam

Figure 46. S-2: Big and long cracks on top of dam body

Figure 47. S-3: Hollow on slope of dam body

Figure 48. S-2: Erosion on slope of dam body

Figure 49. S-1: Collapse of slope protection of dam reservoir

Figure 50. S-3: Breakage on slope protection of dam body

Headworks

Figure 51. S-1: Collapsed headworks

Figure 52. S-3: Crack on headworks spillway

Figure 53. S-2: Big and long cracks on revetment

Figure 54. S-3: Breakage on revetment

Concrete Structures

Figure 55. S-2: Significant breakage of reinforced concrete structure

Figure 56. S-2: Significant breakage on concrete lining on conduit

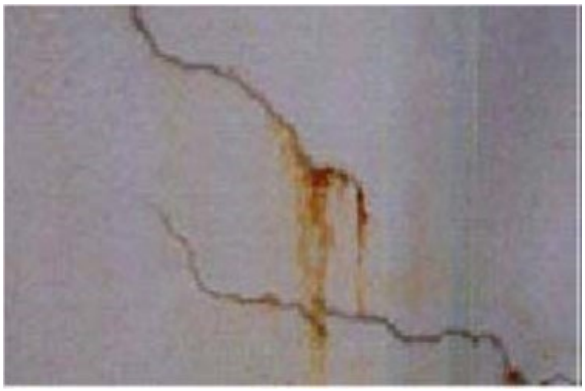


Figure 57. S-3: Cracks and corrosion of rebar inside of concrete

Figure 58. S-3: Alkali silica reaction on concrete

Gate

Figure 59. S-3: Rusting gate

Figure 60. S-2: Corrosion of gate body

Figure 61. S-3: Rusting hoist of sluice gate

Figure 62. S-2: Water leak from gate

Canal

Figure 63. S-3: Erosion on canal

Figure 64. S-2: Significant erosion on canal

Figure 65. S-1: Collapse of canal embankment

Figure 66. S-3: Breakage of concrete canal lining

Figure 67. S-3: Crack on concrete water canal

Pump

Figure 68. S-3: Rust on bearings of pump motor

Figure 69. S-2: Significant corrosion on bearings of pump motor

ANNEX III: A STANDARD CRITERIA IN JAPAN FOR JUDGEMENT OF SOUNDNESS LEVEL FOR REINFORCED CONCRETE LINING WATER CANAL

Soundness level				S-5	S-4	S-3	S-2
Internal factors	Changes in structure	Cracks	Crack width	Maximum crack width: <0.2 mm	Maximum crack width: 0.2 mm<= & <1.0 mm	Maximum crack width: 1.0 mm<=	The S-3 level crack density found overall
				When cracking is progressive, one rank down.			
			Crack scale and seepage			Crack density (crack width: 0.2>=): >=50 cm/m2 and seepage or rust juice	The S-3 level crack density found overall or spring out
			Crack steps				Found
		Deterioration other than cracks	Floating	Nothing	Partially	Overall	
			Peeling	Nothing	Partially	Overall	
			Precipitates (efflorescence, gel, etc.)	Partially	Overall		
			Rust juice	Nothing	Found		
			Abrasion	Fine aggregate exposure	Coarse aggregate exposure	Peeling of coarse aggregate	
				When abrasion is found overall, one rank down.			
			Rebar exposure	Nothing		Partially	Overall
		Compressive strength	Design strength	>=100%	100%> and >=75%	75%>	
		Neutralization	Not neutralized thickness	>=10 mm		10 mm>	
External factors		Deformation/Distortion		Nothing		Partially	Overall
		Loss/Damage		Nothing		Partially	Overall
		Uneven subsidence		Nothing		Partially	Overall
	Changes in surroundings of the structure	Ground deformation	Hollow ground	Nothing	Partially	Overall	
			Cave-in/Cracks in surrounding ground	Nothing	Partially	Overall	
			Ground uplift	Nothing	<20cm	20 cm<= & <50 cm	>=50 cm
Other factors	Changes in peripheral equipment of the structure	Joint deformation	Joint opening	Nothing	Partially	Overall	
			Stepping	Nothing	Partially	Overall	
			Breakage of sealing strip	Nothing		Found	
			Water leakage	Nothing	Seepage	Spring out	
			Loss/Damage of peripheral concrete, etc.	Nothing	Partially	Overall	

Source: MAFF, 2015

ANNEX IV: PILOT TESTING ON IRRIGATION ASSET MANAGEMENT IN LAO PDR

(*Source*: Department of Irrigation, 2023)

The Department of Irrigation (DOI) under the Ministry of Agriculture and Forestry of Lao PDR implemented a pilot testing in 2023 on the Irrigation Asset Management (IAM) referring to a draft version of the MRC IAM Guidance. The objective of the pilot testing was for capacity building on the IAM in Lao PDR and for improving the draft MRC IAM Guidance. The DOI conducted the function diagnosis for irrigation facilities in the KM.35 Project area in Savannakhet province.

The KM.35 Project was completed in 1996 with support by the Japanese government that includes two irrigation schemes, Houay Bak Irrigation Scheme and Houay Xay Irrigation Scheme. The Houay Bak Irrigation Scheme covers the command area of 1,000 ha in wet season and 450 ha in dry season for 7,255 beneficial farmers. The Houay Xay Irrigation scheme covers the command area of 410 ha in wet season and 50 ha in dry season for 323 beneficial farmers.

The results of the function diagnosis were input by the DOI staff and recorded in the ADCA System (Figure 70, Figure 71 and Figure 72).

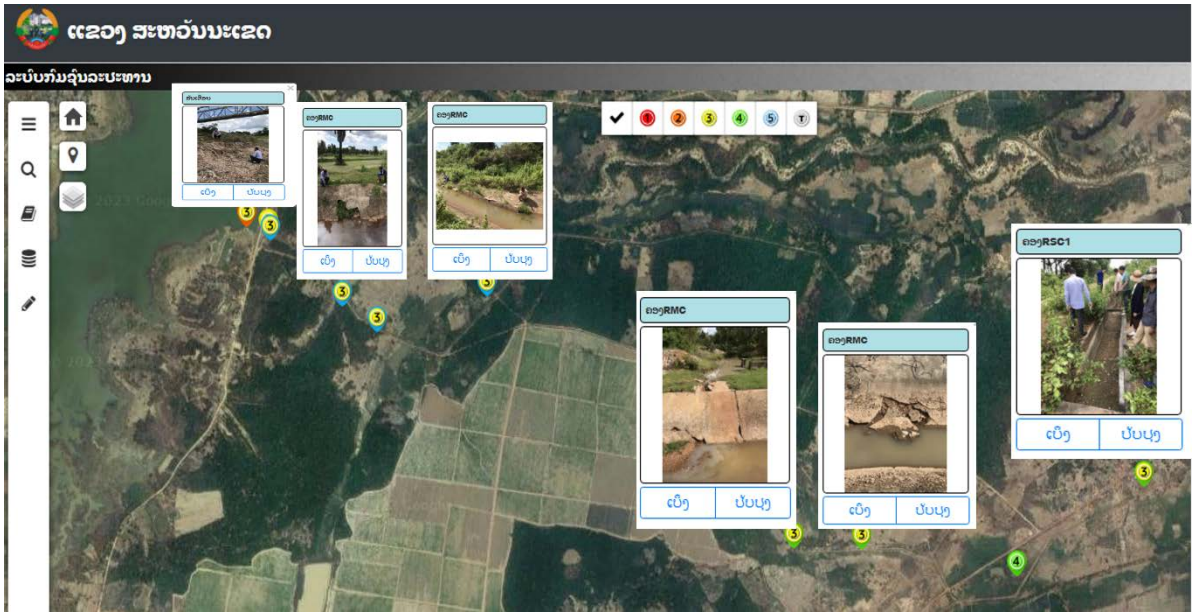


Figure 70. Points of function diagnosis of the Houay Bak Irrigation Scheme in ADCA System

Figure 71. Points of function diagnosis of the Houay Xay Irrigation Scheme in ADCA System

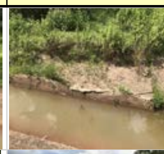
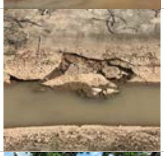
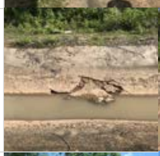
TMP No.	ວັນທີສ້າງ	ຊື່	ປະເພດ	ວັດສະດຸ	ຄວາມສົມບູນ	ຄວາມສຳຄັນ	ບັນທຶກ	ຮູບທີ 1	ຮູບທີ 2	ຮູບທີ 3
1	11/Jul/2023	ຄອງRMC	ຄອງເໜືອງແມ່	ເບຕົງ	S3	A	ໂຄງການຍອດຫ້ວຍບັກ ຄອງRMC ດິນພື້ນຄອງເໜືອງຍຸບໂຕເຮັດໃຫ້ພື້ນຄອງແຕກແຫງ ຂະໜາດຄວາມຍາວ 10m, ເປີນເນີນ2.2m			
2	11/Jul/2023	ຄອງRMC	ຄອງອື່ນໆ	ເບຕົງ	S3	A	ໂຄງການຍອດຫ້ວຍບັກ ຄອງRMC ຝາຄອງເໜືອງຂ້າງຊ້າຍທໍ່ລອດນ້ຳເຮັດໃຫ້ມີນ້ຳກັດເຊາະຂ້າງຄອງຄວາມຍາວທີ່ໄດ້ສ້ອມແປງ 10m			
3	11/Jul/2023	ຄອງRMC	ຄອງອື່ນໆ	ເບຕົງ	S3	A	ໂຄງການຍອດຫ້ວຍບັກ ຄອງRMC ຄອງມີຮອຍແຕກເປັນຈຸດຂະໜາຄວາມຍາວ 106m, ເປີນເນີນ 2.20m+ພື້ນ0,5m			
4	12/Jul/2023	ຄອງLMC	ຄອງອື່ນໆ	ເບຕົງ	S3	A	ໂຄງການຫ້ວຍຊາຍ ຄອງLMC ແຕກຍຸດຂະໜາດໃຫຍ່ຕ້ອງໄດ້ຮັບການສ້ອມແປງເພື່ອຮັບປະກັນການກັດເຊາະຂະໜາຄວາມຍາວ 5m			
5	12/Jul/2023	ຄອງLMC	ຄອງເໜືອງແມ່	ເບຕົງ	S3	B	ໂຄງການຫ້ວຍຊາຍ ຄອງLMC ແຕກຍຸບຂະໜາດຄວາມຍາວ 10mx5m			
6	11/Jul/2023	ຄອງRSC1	ຄອງອື່ນໆ	ເບຕົງ	S3	B	ໂຄງການຍອດຫ້ວຍບັກ ຄອງRSC1 ແຕກຕ້ອງໄດ້ຮັບການສ້ອມແປງເພື່ອຮັບປະກັນໃນການກັດເຊາະ ຂະໜາດ 1m			

Figure 72. Examples of results of function diagnosis recorded in ADCA System

The following are major lessons learned from the pilot testing.

- To make it possible to diagnose the condition of the irrigation facility, weeding should be done before conducting the diagnosis, or the survey should be conducted during the dry season when the surface of the facility has dried up. If any deformation or

deterioration was found, the soundness level and importance level should be entered into the ADCA System using a smartphone. There is no need to input facilities of S-4 and S-5 soundness levels because these facilities need not yet to be repaired.

- The details of the deformation or deterioration should be entered in the "Memo" column of the ADCA System as a reason of the judgement of the soundness level and a future reference. If the scale of the deformation is large, it is necessary to measure the length, width, and height and add them to the "Memo" column. Since there is no character limit in the "Memo" field, it is suggested to input any information as a record for future reference, which would be very useful.
- In the ADCA System, coordinates and a name of a surveyed point are automatically input when the surveyed point is registered. However, since the automatically input name is not always proper name for reference, it is suggested to change the name to more proper name so that the facility of the name can be easily understood by the others.
- It is suggested to take three photos of each survey point by a smartphone as much as possible and to upload the photos to the ADCA System. When taking the three photos, it is desirable to include 3 types of photos such as a distant view, a near view, and with measuring so that the deformed condition of the point can be easily understood.

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