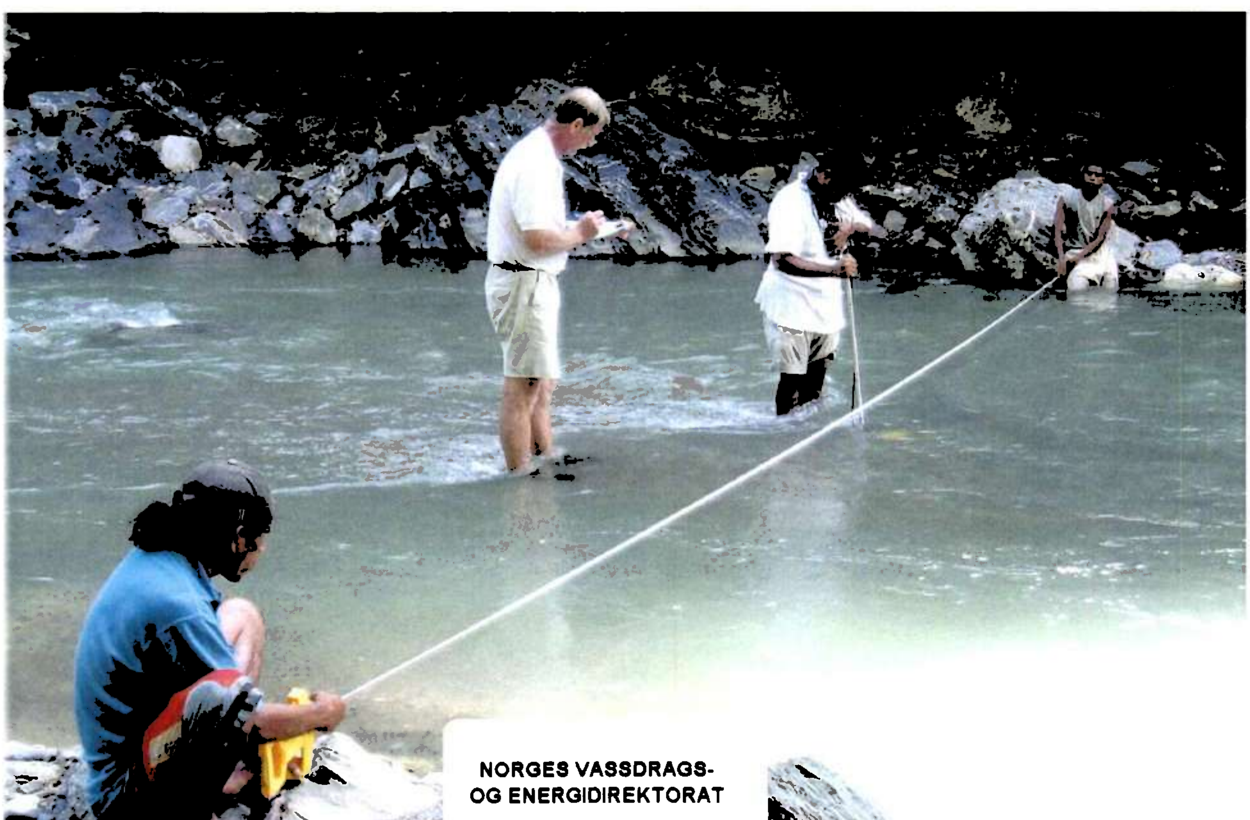
Institutional co-operation between
The Ministry of Transport, Communication and Public Works, Timor-Leste,
and
Norwegian Water Resources and Energy Directorate (NVE), Norway

WATER RESOURCES MONITORING AND ORGANIZATION IN TIMOR-LESTE

Mission Report April 2005

Aud Skaugen
Kjell Repp



August 2005

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1 Executive Summary

A hydrological mission to Timor-Leste was conducted during April 2005, regarding the institutional cooperation between The Ministry of Transport, Communication and Public Works (MTCPW) and the Norwegian Water Resources and Energy Directorate (NVE).
The objective of the mission was:

1. To propose a structure and organisation for a Hydrological Unit in Timor-Leste;
2. To propose a manpower development plan within hydrology;
3. To recommend purchase of hydrological equipment for the hydrological network to be established
4. To follow-up the cooperation between MTCPW and NVE

Two workshops were organised, one on Integrated Water Resources Management (IWRM), and one on Hydrology. Based upon discussions during the workshops, three field visits, discussions with a number of government officials and expatriate advisors, and a summing-up meeting at the end of the mission, the following recommendations have been made (not prioritized):

- In order to facilitate IWRM, the local community must be involved.
- One ministry should have the overall responsibility for the water sector, with inputs from other ministries.
- A high-level interdepartmental coordination committee should facilitate the exchange of hydrological information, communication and cooperation to the best interest for Timor-Leste.
- As a short term solution an executing hydrological unit could be placed within the ALGIS-section, and additional staff seconded to the section from other ministries dealing with water. As a long term solution a new government agency for water resources monitoring and analyses may be formed, independent of "sector-wise" ministries.
- Collection of hydrological data should be decentralized, but administered by the central government.
- 1 experienced full-time hydrologist and 1 meteorologist is needed for 2 years (preferably 5 years).
- 2-3 skilled technicians are needed for the operation of the hydrometric stations.
- 5 skilled observers for part-time water-level observations are needed, and approximately 50 skilled observers for part-time rainfall observations.
- Short-term as well as long-term education/training programmes should be initiated as soon as possible.
- Hydrometric instrumentation should be standardized, in order to provide sustainability.
- 50 manual rain gauges, 2 tipping bucket rain gauges, and 5 water level stations should be rehabilitated/installed as soon as possible at identified locations.
- IWRM is of outmost importance, in order to make fair and correct priorities regarding the use of limited water resources.

2 Introduction

A hydrological mission to Timor-Leste has been conducted by the Norwegian Water Resources and Energy Directorate (NVE) during the period of April 5^{th} – 25^{nd} 2005, regarding the institutional cooperation between The Ministry of Transport, Communication and Public Works (MTCPW) and NVE. The members of this mission have been:

Ms. Aud Skaugen
Mr. Kjell Repp

The object of the mission has been defined in a Terms of Reference dated 13^{th} March 2005 as follows (Appendix 1):

- To propose a structure and organisation for a Hydrological Unit in Timor-Leste;
- To propose a manpower development plan within hydrology;
- To recommend purchase of hydrological equipment for the hydrological network to be established
- To follow-up the cooperation between MTCPW and NVE

The team shall review documents, attend in meetings with relevant persons and carry out two workshops.

This report presents the findings by first a presentation of the status of the water management with relation to hydrological services, and then a description of the proposed Hydrological Unit, the institutional framework, human resources and hydrological equipment. Finally, the report approaches the other relevant issues in the institutional cooperation.

3 Background

A contract between Ministry of Transport, Communication and Public Works, Timor-Leste, and the Norwegian Water Resources and Energy Directorate (NVE) regarding Institutional Strengthening of the Power Sector in Timor-Leste was signed on 18^{th} February 2003.
Pre-supposing this institutional contract, funds for a project titled "Assistance in Developing the Management of the Power Sector in Timor-Leste" was granted by Norway, through NORAD, in an agreement signed 3^{rd} and 4^{th} February 2003 respectively.
The overall goal of the Project is to contribute to the economic and social development of Timor-Leste through assistance in developing the management of the power sector in Timor-Leste.
An important pre-condition for the achievement of the overall goal is reliable water resources assessment and management, and hydrological investigations have therefore been included in Phase 1 as well as Phase 2 of the Project.
Phase 1 should include an "assessment of need for hydrological network, and detailed plans for establishment of gauging stations". Associated personnel for training and training activities should be identified.
Phase 2 emphasises the human resources development and capacity building, and should amongst others include (ref. contract)

- Improving/upgrading of hydrological network to strengthen water resources management, including the development of hydropower.
- Developing a database and information system for collected data.

- The preparation of national and basin water resources plan.

Amongst others, the latter point will necessitate a thorough knowledge about water uses and water demand throughout the country.

The Asian Development Bank (ADB) has been present in Timor-Leste since 2002, and has during that period undertaken a number of studies and prepared numerous reports on Integrated Water Resources Management, including hydrology, under the project ADB TA:TIM 3986. The set of 7 No. ADB TA:TIM 3986 outputs to date comprises:

1. *Environmental, Social & Institutional Working Paper*
2. *Water Availability & Water Demand in Timor-Leste (incorporating a Preliminary Assessment of Sustainable Groundwater Yield)*
3. *Hydrometeorological Network & Data Management Report*
4. *Guidelines for Hydrometeorological Network for Timor-Leste*
5. *Water Resource Supply & Demand Assessment at River Basin Level*
6. *A set of 3 Legislative Framework Recommendations, and*
7. *A draft National Water Policy*

Additional to these reports, the TA has implemented extensive IWRM awareness raising activities for all levels of Government and other stakeholders.

This ADB TA will finish, but may initiate a new technical assistance project within infrastructure, water supply and sanitation later this year or next year.

4 Integrated Water Resource Management and Hydrology

The institutional cooperation is, as mentioned above within the energy sector and water resources management. As Timor-Leste has potential but not well proven hydropower resources, collecting more information about the water resources and the hydrology is necessary. And a project like this has to be harmonised and if possible integrated with other water projects to provide for sustainability.

> ***The"Water Vision" of Timor-Leste***
>
> ***The people of Timor-Leste together will enjoy:***
> ***-Access to safe, adequate, and affordable sources of water for drinking, sanitation, and other household purposes***
> ***-sufficient water to provide for food security, the requirements of industry and employment, and other human needs***
> ***-the freedom from the threat of loss of life, property and livelihood as the result of floods, droughts and other water related disasters, and***
> ***-a water environment that sustains healthy aquatic ecosystems and fisheries"***
>
> ***Ref: draft National Water Policy***

Water is an important key to sustainable development. There is no substitute for water, and providing water security is necessary in poverty reduction. However, this is a challenge for the government. Different activities have been initiated in order to meet this challenge. As stated in the draft Policy Document, the government has drafted an overall goal for management of the Nation's water resources:

To ensure the management of the Nation's water resources in an efficient, equitable and sustainable manner, meeting the social and economic needs of present and future generations of Timorese, protecting the bio-physical environment, and fostering the national and cultural values of the people (ref. draft policy doc.).

To meet this goal it will be important to have established good governance as well as good knowledge of the water resources and all the users' plans for water consumption.

Timor-Leste is in the process of defining the necessary amount of water consumption within the different sectors. Water, Sanitation and Agriculture has carried out rapid water assessments and capacity building and the energy sector is starting a hydrological survey and capacity building to support the hydropower development.

4.1 Integrated Water Resource Management, IWRM

IWRM is a method for the process in water management, in order to satisfy the different water demands, the water value and the roles of the stakeholders to ensure sustainable development.

Theoretically, all the water-projects should include IWRM components. However, this is a rather new way of thinking and the implementation is a challenge.

In order to succeed, identification of all the different IWRM components is important in the initial phase of a project. This does not mean that all projects need to include all sectors and stakeholders, but information is important. On the other hand, consideration of all strategic elements most probably ensures the sustainability of the project.

Elements in IWRM

- ***Policy and legal framework***
- ***Institutional structure and capacity***
- ***Information and knowledge***
- ***Finance and economy***
- ***Resources and environment***
- ***International cooperation***
- ***Stakeholder attitude and engagement***

The Government of Timor-Leste has adapted the Millennium Development Goals of UN to introduce IWRM and to develop National Water Management Plan by 2005.

The ADB has since Feb 2004 given Timor-Leste technical assistance in IWRM and assisted Timor-Leste in developing a draft water policy document. The process has included engagement from the three ministries that are responsible for water resources according to the Constitution, in addition to other stakeholders.

ADB have put a lot of effort into awareness campaigns/projects both at governmental, non-government and community level. This has been important to ensure ownership of the policy document as it will be the key to implement IWRM in Timor-Leste.

Also other important elements towards implementation of IWRM are proceeding. An organic law was developed by the UN and will be revised when the government is ready. Timor-Leste has started the process of developing both a new legal framework and the governmental institutions regarding water-management issues. The ADB TA has proposed an overall legislative framework to promote IWRM, and has prepared legal structures – i.e. a draft organic law - for a cross-ministerial water resource coordination committee as an apex water resource management body. It has also prepared legal structures for water resource control and licensing of high-volume and commercial water users.

The Norwegian assistance and this mission's outcome have to harmonise with this development.

A half day workshop in IWRM was arranged 12 April. After some presentations in planning and management and about experience from implementing IWRM in developing countries there was an initial discussion regarding risk factors in implementing IWRM in Timor-Leste.

The group identified some clear risk factors, which further assistance in IWRM (from Norway) should try to minimise as much as possible.

The workshop identified risk factor in implementing IWRM in Timor-Leste

The workshop proposed the following risks – (not prioritised):

- Identify small starting actions
- Regulations vs. currant governmental structure
- Communication and collaboration
- No-one overall in charge (several ministries)
- Human Resources

4.2 Hydrology

Hydrology is the science that deals with the occurrence and distribution of the waters of Earth, including their chemical, biological and physical properties, and their interaction with the physical environment. As such, it is the basis for solving practical problems of floods and droughts, erosion and sediment transport, and water pollution.
Indeed, increasing concerns for the pollution of surface waters and ground waters, acid rain, drainage of wetlands and other types of land-use change, together with the threats to water resources posed by climate change and sea-level rise, have highlighted the central role of hydrology in many environmental initiatives.

Therefore, some kind of hydrological services is a prerequisite for any water resources management in any country. Normally, the service as a minimum includes the basic operational hydrology, as defined in the WMO General Regulations, ANNEX III [1]:

(a) The measurement of basic hydrological elements from networks of meteorological and hydrological stations: collection, transmission, processing, storage, retrieval, and publication of basic hydrological data;

(b) Hydrological forecasting;

(c) The development and improvement of relevant methods, procedures, and techniques in:
- (i) Network design;
- (ii) Specification of instruments;
- (iii) Standardization of instruments and methods of observation;
- (iv) Data transmission and processing;

(v) Supply of meteorological and hydrological data for design purposes;
(vi) Hydrological forecasting.

It should be noted that hydrological data here are taken to include data on the quantity and quality of both surface water and groundwater. Operational hydrology is therefore strongly interrelated with water resource monitoring and water resource management.
Briefly, the overall objective of a hydrological service is:
"To ensure the assessment and forecasting of the quantity and quality of water resources, in order to meet the needs of all sectors of society, to enable mitigation of water related hazards, and to maintain or enhance the condition of the global environment."
A key element of the development process for the National Water Policy and progressive implementation of Integrated Water Resource Management in Timor-Leste is the development of a hydrometeorological monitoring framework for the collection, storage and dissemination of rainfall, climate, stream flow, groundwater and water quality data.

There is a wide-ranging need for hydrometeorological data for present and future national and sectoral objectives. Primary sectors with present and future hydrometeorological data needs are agriculture and forestry, water supply, transport and infrastructure, environment, health and disaster planning (e.g. flood forecasting).

At present, there are hardly any regular water resources monitoring going on in Timor-Leste, except for some sporadic monitoring of water quality and water level in ground water wells. Regular monitoring of water level and discharge were initiated by the hydropower studies a couple of years ago. These stations, which only include two rivers, the Iralalaru and the Laclo, are typical project stations with non standardized equipment, and most of the monitoring and analyses have been carried by consultants. The project, however, has carried out basic training of one technician in Norway as well as on-the-job training in Timor-Leste. Two workshops have been carried out: A one-day workshop in February 2004 on operational hydrology, and a half-day workshop on hydrometric networks in April 2005.

The tasks of the hydrological service:

To ensure the assessment and forecasting of the quantity and quality of water resources, in order to meet the needs of all sectors of society, to enable mitigation of water related hazards, and to maintain or enhance the condition of the global environment.

5 Institutional Framework

5.1 Organisational Structure of the Water Sector

As mentioned above an organic law was developed by the UN and the law will be revised after some while. Also the organic structure of the first constitutional government will change.

The team has the last few days of the mission been informed of a draft proposal of a new structure regarding water management. However, the organic structure of the existing government that rules Timor-Leste is in accordance with the provisions of the constitution and laws.

The Government shall according to the constitution be headed by a Prime Minister and shall comprise the following government departments:

Ministry of Foreign Affairs and Cooperation
Ministry of Justice
Ministry of Planning and Finance
Ministry of Development and Environment (MDE)
Ministry of Transport, Communication and Public Works (MTCPW)
Ministry of Internal Administration
Ministry of Agriculture, Forestry and Fishery (MAFF)
Ministry of Education, Culture, Youth and Sports
Ministry of Health
Secretariat of State of Defence
Secretariat of State of Labour and Solidarity
Secretariat of State of Trade and Industry
Secretariat of State of the Council of Ministers

According to the Constitution and the organic law MDE, MTCPW and MAFF have responsibilities that include water resources. In addition, Min.of Health and Min. of Internal Administration will be involved regarding the implementation of the proposed water policy document.

It should be noted that during the time of the mission there were discussions going on regarding some restructuring of various ministries and departments in the near future. This report describes the structure in April 2005. The various recommendations might be considered independently of the government structure, however.

5.1.1 Ministry of Development and Environment (MDE)

According to the Constitution of the Democratic Republic of East Timor:

"The Ministry of Development and Environment is the government department responsible for designing, executing, coordinating and assessing the policy, as defined and approved by the Council of Ministers, for the areas of promotion of and support to investment, development of tourism, as well as for the areas of energy, natural and mineral resources and environment, under the terms to be defined in its organic law."

Department of: Environment, Investment and Tourism, Development, Minerals and Natural Resources, Energy, and Administration.

MDE does not have any districts offices at the moment.

There is an international expert from UNDP assisting MDE and it is not clear if the Ministry has human resources to conduct more than they already are obliged to.

5.1.2 Ministry of Transport, Communication and Public Works (MTCPW)

According to the Constitution of the Democratic Republic of East Timor:

"The Ministry of Transport, Communication and Public Works is the government department responsible for designing, executing, coordinating and assessing the policy, as defined and approved by the Council of Ministers, for the area of transport and communications, including telecommunications and postal services, as well as for the area of management of national water resources and meteorology services, under the terms to be defined in its organic law."

Departments with linkage to water: Water and Sanitation (SAS), Electricity Service (EDTL), Road, Bridges & Flood Control, Meteorology

Decentralised 13 Districts offices (SAS), in addition EDTL has 50-60 stations/offices around the country.

5.1.3 Ministry of Agriculture, Forestry and Fishery (MAFF)

According to the Constitution of the Democratic Republic of East Timor:

"The Ministry Agriculture, Forestry and Fishery is the government department responsible for designing, executing, coordinating and assessing the policy, as defined and approved by the Council of Ministers, for the agriculture sector, namely in the fields of farming research and technical assistance to farmers, including irrigation systems, forest management and cadastral organisation, as well as for the fisheries sector, under the terms to be defined in its organic law."

Departments: Irrigation (including the ALGIS-unit (or section), Forestry, Fishery, and others with less relevance to water.

Decentralised: 13 Districts offices and 9 local offices.

5.2 Hydrology and Meteorology

5.2.1 Network

In the past the hydrometeorological network consisted of 4 AWLR's (automatic water level recorder), 2 manual stations only equipped with staff gauges, seven climate stations [1)] and 64 rainfall stations [2]. During the Portuguese colonial times 38 of the rainfall stations were equipped and operated as climatological stations. Monthly rainfall data for most of the stations in the country has been collected from the Indonesian Meteorological and Geophysics Agency (BMG, Jakarta) for the period 1952 to 1974 and is shown in [2]. The rainfall stations were spatially well distributed over the country, but located mostly in the lowlands (60 % below 500 m amsl). The locations are shown in Figure 5.1.

[1)] Observation parameters at a climate station normally include rainfall, evaporation, temperature, wind, solar radiation and humidity.

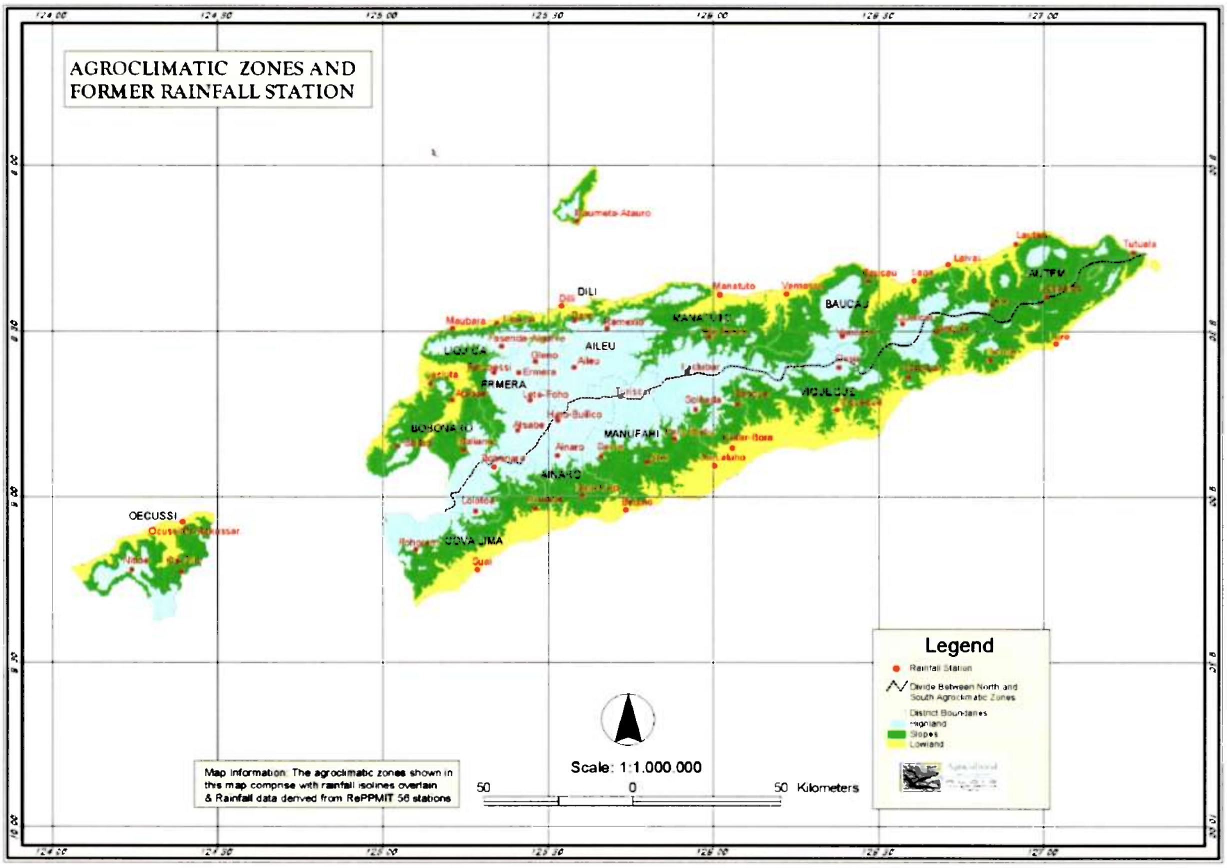

Figure 5.1 Rainfall stations in Timor-Leste during the Portuguese period.

The rainfall data from the period 1952 – 1974 is indicated to be of rather good quality [2], while data made available for the period 1974 – to date are very broken and probably more or less useless.

No data are available for the 6 water level stations [2], while records for the water level station at Iralalaru has been obtained from September 2003, and used in the Hydropower Study of the Iralalaru [3].

Agro-climatic data such as evaporation, temperature and relative humidity have been available for the period 1952 – 1974 [2]. The records are broken and scattered, however.
4 agro-climatic stations were installed in July 2004, and have since then been operating satisfactorily. The stations are operated by MAFF. The World Bank (WB) has agreed to finance another 7 agro-climatic stations.
As a conclusion on the existing hydrometric network it may be said that it will have to be built up almost from scratch, except for the new agro-climatic stations and the water level station at Iralalaru.

The ADB TA has prepared a Guideline for the reestablishment of a Hydrological Monitoring Network in Timor-Leste [4]. This guideline has been endorsed by the Ministerial-level TA Steering Committee, but has to be accommodated to available resources. An extract from the Guidelines is given below.

"Based on previous hydrometeorological networks in Timor-Leste, previous studies, analyses and recommendations for Timor-Leste, guidelines from the World Meteorological Organization, and discussions, observations and analyses during this project, the following national hydrometeorological network is recommended:

- *60 rainfall stations.*
- *11 climate stations.*
- *Between 10 and 15 stream flow and water level monitoring stations.*
- *Between 10 and 15 groundwater monitoring stations.*
- *Water quality monitoring sites.*

These Guidelines present details of the design and implementation of a suitable hydrometeorological network to meet national and sectoral needs (based on WMO-No.168 "Guide to Hydrological Practices"). In particular, the Guidelines cover the following elements:

- *Guiding principles for the development of a hydrometeorological network.*
- *Required elements of a hydrometeorological network.*
- *Siting requirements.*
- *Recommended locations (rainfall and climate monitoring stations).*
- *Priorities for implementation.*
- *Functional specifications for equipment (rainfall and climate monitoring stations).*
- *Operation and maintenance requirements (rainfall and climate monitoring stations"*

5.2.2 Database

At present there is no computerized hydrometeorological database in Timor-Leste.
The Asian Development Bank - funded Technical Assistance Project (ADB TA:TIM 3986) for Integrated Water Resource Management in Timor-Leste is installing a Hydrometric Database, however, to store a 'national' archive of climate and water resources information.
This fits within the coordinated donor approach to establish an appropriate National Hydrometeorological Monitoring Network in Timor-Leste:

- "*Hydrometeorological Monitoring Network Guideline*" (ADB TA)
- Procurement and installation of a database suited to primary data processing & storage and training (ADB TA)
- 4 Agro-climatic monitoring stations (CIRAD)
- 7 Agro-climatic monitoring stations and some low flow stream gauging at irrigation schemes by the 3rd Agricultural Rehabilitation Project (ARP III)
- Network of 50 manual read rain-gauges, and 5 run off stations. (Norwegian Water Resources & Energy Directorate - NVE)
- Other donor project-related rainfall and water resource assessments, such as operated by the University of Hawaii Livelihoods Project, the AusAID funded Community Water Supply & Sanitation Project, etc.

This database will be a valuable platform for the national hydrometeorological services to be established in Timor-Leste. The database is procured as a single-seat license, however, meaning that it allows only one operating station and one user at one time. This will necessitate a close cooperation between the various users. In the short-term perspective, i.e. the first couple of years, this will probably not be a problem. It should be considered to procure one or two more licences as additional staff is being trained and getting familiar with the database, however. This will allow other users such as the Department of Meteorology, the Electricity Department, Road and Flood Control Department, etc to input, manipulate and extract water resource data.

The procurement contract includes a **five-year** maintenance (i.e. support) period. This will provide:

- automatic (and free) upgrades to the software as they occur (ongoing development and improvements to the system);
- bug fixes, problem solving, trouble shooting, etc.;
- remote technical support/assistance via e-mail, fax, phone, etc. usually within 24hrs; and
- operator assistance with database maintenance, population, operation, etc.

After consideration of the needs of each Government Ministry with water related functions, and of issues such as current levels of staff capabilities and the likelihood the database will be well maintained (i.e. sustained), the ADB TA recommended the database should be located initially within **ALGIS** - **A**gricultural **L**and **G**eographic **I**nformation **S**ervices - of the MAFF Research and Extension Centre. This recommendation has been endorsed by the ministerial-level Steering Committee.

6 Hydrological Unit

The institutional cooperation between MTCPW and NVE includes assistance in establishing a hydrological network, improve the data collection, handling and analyses in the hydrological sector, and to advise on equipment to be purchased. NVE recommend the establishment of a Hydrological Unit within the governmental sector, for servicing all users of water and to facilitate integrated water resource management and planning.

6.1 Organisation and responsibility of the hydrological unit

It is widely accepted that IWRM would include actions of capacity building and sharing knowledge and of course the different roles in good governance.

One of the roles of the government, including local government, would be to include local communities. People at the local level actively manage many aspects of water resources. Some times they have a better understanding of potential and limitation of the local environment and they can be empowered to meet this role. The proposed institutional framework will look into the possibility of including local communities by delegating the responsibility for collection of rainfall-data.

The organisation of the water sector and the responsibility for the establishment of a hydrological unit could affect the water allocation and be a mean to regulate the abstraction and the use of water. The team has during the mission received information that there is a lack of a governmental body with the overall responsibility of the water (see above chap.4). The team has also received information that there will most probably be some changes within the organisation of the water sector. The government in Timor-Leste is developing the structure. In April 2005 there are more than four ministries handling water issues. This may enforce communication and cooperation which are very important in IWRM. However, in order to reduce the potential (allocation) conflict between the different water demands and externalities it would require some form of governmental intervention.

Some of these challenges could probably be met if one of the Ministries had the overall responsibility of the water. This would certainly not have to exclude the responsibility for the different ministries to handle water issues that are important for their own sectors.

It has not been possible for the team to propose a structure and organisation of the hydrological unit without including elements for where in the governmental structure the responsibility for water should be and how to organise it.

It is the team's proposal that one ministry should have the overall responsibility for the water sector with input from other ministries. This will require a change within the constitution and the organic law. If this is possible in a short period of time depends on the priorities and the changes the government will enforce to get the policy document approved. In addition to that the structural changes may also include what the team proposes.

However, each ministry with sector wise responsibility that includes water should have the responsibility for this, based on the national water policy and coordination with the other ministries. A common delegation of responsibility means that the character of the different executive authorities can be a key variable in implementing an efficient policy.

The team has received information that water does not have very high priority in Timor-Leste. The approach for our findings and the recommendations have been to rely on existing governmental bodies and their responsibility without to many changes or revised organisations.

6.1.1 Responsibility

It is the team's suggestion that the responsible ministry should organise the hydrologic unit in such a way that it would be impossible to "bargain" and manipulate the operator of the unit, or figures in the database, in interest of the regulated sector (ecology, water-supply, irrigation, industry or hydropower).

All the different sectors are important to ensure sustainable development. To find a way to organise the sectors is crucial in order to establish integrated water resource management (IWRM). Different interpretation of the responsibility of the different ministries may conflict with development interest. IWRM requires coordination, communication and cooperation, but sometimes decisions have to be taken based on national priorities.

A draft policy document has been produced by ADB in cooperation with a ministerial-level interdepartmental Steering committee. However, the responsible ministry for implementing the water policy is not decided (April 2005). The ADB TA is also proposing that primary water resource stakeholders should have permanent representation on the NWR Coordination Committee formed to guide the implementation of the NWR Policy [5].

This may take some time, but in order to find a simple solution that may be decided within a short period of time, the team proposes the new ministry with the responsibility of natural resources as the responsible governmental body, to ensure the overall management of the water resources.

> ***The team proposes:***
>
> ***That the overall responsibility of implementing and to secure reliable and useful data should be within the ministry responsible for natural resources***

Due to the Constitution of the Democratic Republic of East Timor, the Government enacts the following mandate for MDE in the Organic Structure:

"*The Ministry of development and Environment is the government department responsible for designing, executing, coordinating and assessing the policy, as defined and approved by the Council of Ministers, for the areas of promotion of and support to investment, development of tourism, as well as for the areas of energy, natural and mineral resources and environment, under the terms to be defined in its organic law.*"

6.1.2 Coordination

As described above, it is necessary to organise the sector to secure good information from all sub-sectors to secure IWRM.
The team suggest a high-level interdepartmental coordination Committee as a governmental body for conducting exchange of hydrological information, communication and cooperation to the best interest for Timor-Leste.

> ***The team proposes:***
>
> ***To re-establish the Steering Committee for the purpose to coordinate the different demands and of organising the hydrological unit, with the responsibility of implementing a database reliable and useful for IWRM.***

Motivated persons with interests in water issues and with high level positions in their ministries should be members of this Committee.

If possible, it could be an idea to re-establish the previous Steering Committee involved in preparation of the policy document. However, it is our opinion that the ministers themselves should not take part in this Committee but be responsible for appointing the right person (high-level).

The Coordination Committee would be important to bring the water up on the agenda. In addition the Committee would coordinate the management of the water resources and be able to coordinate the work of the hydrological unit to ensure a reliable database for all users. This coordination group should also be responsible for dissemination of water information and awareness campaigns.

6.1.3 Executing Agency for water resource data management (recommend not for coordination or overall water resources management)

The hydrological unit should (as far as possible) be an executing agency with general delegated responsibility, not only required to enforce specific measures or perform tightly defined duties. If the agency has the flexibility to interpret what the responsibility means, and can develop their strategy to meet them, the development may go faster than if they receive defined duties. However, this way of organising the work demands competent and reliable staff.

The team recommends:

An extension of the duties in the ALGIS to also include data collection and data handling to serve the other ministries and the water Management in Timor-Leste.
The staff should reflect as many of the sectors in IWRM as possible

The Ministry of Agriculture, Forestry and Fishery (MAFF) has as mentioned above (Chapter 5.2.2), established a GIS-unit (ALGIS), with amongst others responsibility of preparing maps and of the database for the ministry.

ALGIS - Mission statement:

"Support the Ministry of Agriculture Forestry and Fisheries in planning and delivery of inputs to agricultural, forestry and fisheries sectors in Timor -Leste and in particular provide the Ministry with the best available information and highest quality maps on land use and land use potential, agricultural production and production trends, as basic for natural resource management and decision making."

It could be a solution to extend the mandate for this unit to also implement the database for the other sub-sectors. Once again the interpretation of the responsibility and loyalty to the ministries may be a challenge. However, this may function if the responsibility of the priorities and coordination between the different ministries and sectors was to be taken care of in the coordination group.

By including the responsibility for handling of hydrological data into this section, future workload and increased data-handling may stress the capacity of the employers. It may also be considered to increase the number of staff, e.g. with one person with some basic knowledge of hydrology.

Regarding the executing agency for a hydrological unit to serve the whole water-sector, the team do not find it as a long term optimal solution to be within one ministry. However, as a short term solution the GIS department could include personnel from MTCPW. This would give a broader perspective regarding the responsibility, loyalty and professional skills. In addition to that the staff would be more flexible and prepared to handle future work. If or when the decision of including water quality data appears, then the ALGIS-team should be extended with a person with background to deal with this. The team has not followed this issue in this mission but, professional skills to conduct this work may exist in SAS or in the MDE.

As a long term solution this unit may be a new governmental or a private agency. However, this will need resources and long term capacity building. The agency could be financed by selling data, analysis and other hydrological information. Privatization of hydrological and water resources services have lately been discussed in many countries, and a few countries have implemented parts of these services, with more or less success.

Establishing a private agency, however, would require good regulation and a strong governmental body to ensure reliability and that enough data is collected, even if there is no market for the data immediately.

6.1.4 Collecting data

The institutional cooperation between NVE and MTCPW includes installation of several rainfall-stations. The data from these stations have to be followed-up and reported to the ALGIS who will handle and manage the data, while various ministries and departments will be the users of the data. A lot of information needs to be collected around the country. ALGIS will not have sufficient staff to collect all the data, and it is not recommended that the data collection should exclusively be carried out from Dili.

The team recommends that this should be carried out by the different local government district offices, or by appropriate EDTL / SAS / Agricultural extension officers based around the country. As a part of strengthening local communities, personnel in the districts should be trained and allocated responsibilities to do this job.

On the other hand, capacity building and sharing knowledge is important in Timor-Leste. The team would recommend that the possibility of cooperation with the schools in collecting the data, should be investigated further. Data collection and simple analyses might then be combined with education increasing the school children's and public awareness of the importance of water resources.

6.2 Human Resources

6.2.1 The need

Skilled and committed staff is a crucial requirement for a successful and sustainable water resources monitoring system. In addition to necessary computer skills, most hydrological services recognize three categories of personnel, namely professional hydrologists, hydrological technicians and hydrological observers. The World Meteorological Organization's (WMO) *Guidelines for the Education and Training of Personnel in Meterology and Operational Hydrology* [6] defines these categories as follows:

(a) Professional hydrologists —
This is personnel with a university degree in civil engineering, agricultural engineering, mining, geology or geophysics or the equivalent, which have subsequently specialized in hydrology or other fields related to water sciences. Their tasks and activities can range from management of Hydrological Services to research and training and may include hydrological design of water-resources projects and analysis of hydrological data;

(b) Hydrological technicians —
The personnel of this category can be divided into two groups:
(i) Those with 12-14 years of primary, secondary, and supplementary education, including specialization in one of the hydrological activities; and
(ii) Those with 10 years of primary and secondary education and technical hydrological training.

The personnel of the first group are referred to as senior technicians and the second group as junior technicians. Their duties include assisting professional hydrologists and supervising the work of hydrological observers. More specifically, they deal with duties, such as special measurements, data collection and processing, installation of hydrological equipment, and training of hydrological observers.

(c) Hydrological observers —
The basic education of this category is at least nine years of primary and secondary schooling, supplemented by technical training in one of the fields of hydrological activity. Their duties include taking observations, keeping records, and maintaining less sophisticated instruments installed at their duty stations.

WMO and United Nations Educational, Scientific and Cultural Organization (UNESCO) have also recommended the number of staff required in each of the above categories related to the size of the observational network. It should be noted that most of the observers may be assumed to work part-time or to be volunteers, and thus do not form part of the full-time staff of the hydrological services. They are largely trained on the job, while technicians will have some formal post-school technical college training, as well as a large element of on-the-job training. Professional hydrologists, on the other hand, will be graduates of a university-level institution. First-degree courses rarely specialize in hydrology so the degree subject will be in civil engineering, environmental science, geography, science (particularly one of the geosciences), agriculture, or a similar subject. Many professional hydrologists also take a postgraduate diploma or master's degree and, at this level, courses specializing in hydrology or water resources are widely available.

With the agro-climatic stations already installed, and the seven others to be installed in the near future, Timor-Leste will need one professional meteorologist/climatologist to make full use of the data collected. The data, which will provide a useful tool for planning of agricultural production and types of crops etc., are more or less useless without an experienced and professional to do data quality control and the necessary analyses.

The same conditions apply to the hydrological data which are needed for water supply planning, irrigation, hydropower development, and environmental considerations. Only a professional hydrologist can fully utilize the new database with the software. Without an experienced and professional hydrologist the database can only be used as a database for storing data, and only simple analyses will be performed. For the operation of the stations, whether it being a climate station or a water level station, three skilled technicians, at least one specialised in electronics, are needed. In addition, skilled observers for the water level stations are vital. With the proposed hydrometric network, approximately 5 observers will be needed for the water level stations.

<u>Minimum Staff requrement:</u>

1 Metorologist
1 Hydrologist
3 Hydrological technicians
5 Water-level observers
Rainfall observers (number to be defined later)

6.2.2 Present level

ALGIS has at present three persons employed. Due to the responsibility of the ministry in charge (MAFF), they all have their basic education from agriculture and forestry.

- *Adalfredo Do Rosario Ferreira*, Manager of the Unit.
  Bachelor degree in Forestry Sciences. His responsibility:
  - is to lead and coordinate the work within the Unit.
- *Raimundo Mau*, GIS Database Specialist.
  Bachelor degree in Agriculture Sciences. He has been trained by the French who delivered the equipment they have today. The training included handling the computer and to analyse the data, which he forwards to the crop-department. The databases are available at the internet. Mr. Mau communicates with experts abroad when he has problems with the database. He expressed the wish of having more training in computer-handling and databases. His responsibilities:
  - Maintain and further develop the agricultural and thematic databases
  - Undertake spatial and overlay analysis for map production
  - Train staff from other Divisions in database development and management
- *Francisco Sarmento*, land use planner.
  Bachelor degree in Agriculture Sciences. Mr. Francisco been trained to use and maintain the French equipment. His responsibilities:
  - Carry out survey of land use and production
  - Produce and update district land use maps on a regular basis
  - Implement, collect and interpret data from regular agriculture survey

Within MTCPW, in the department of water and sanitation (SAS) there is also a person who may be given positive extension to ALGIS in order to give ALGIS a more holistic approach

- *Joaquim Manuel da Costa Ximenes.*
  Diploma in Electro technic. Post graduate course in Management. He has also attended training in computer – software, Office, Auto Cad, Espanet, Win Caps, Arc View and map source and GPS.
  Based on the future demand for hydrological date for hydropower, Mr. Joacim has been in Norway for hydrological training as well as on-the-job training in Timor-Leste.
  His has working experience from water supply, water and sanitation and water resource management.

6.2.3 Training programme

6.2.3.1 Long Term

A professional meteorologist/climatologist and a hydrologist should be appointed as soon as possible, and a suitable university in one of the neighbouring countries should be selected. Considering language problems, Indonesia might be preferred. This is considered as a long-term education/training, as the time needed to obtain a university degree will probably exceed 5 years, and the two professionals will also need post-graduate training. The post-graduate training might be carried out in several countries with the necessary competence and capacity. These professionals should be obliged to work for a certain number of years for the government, depending upon the duration of their scholarships. If a staff member receives a scholarship for instance for a 5 year study at a university abroad, he or she should be obliged to work for the government for the same number of years, or repay the scholarship.

6.2.3.2 Short Term

With regard to hydrological technicians, one staff member from Water and Sanitation at EDTL has already received some basic hydrology training in Norway, as well as on-the-job training in Timor-Leste. He has also got some education in electronics, and will therefore be a natural choice as one of the future staff of a Hydrological Unit in one of the departments.
It should be kept in mind that hydrological technicians are very marketable, because they are technically skilled and numerate, and commonly are quickly promoted, transferred, or assigned other duties. It is therefore not sufficient to train only one person. In Timor-Leste, at least two persons should be trained, with on-going provision for training of an additional person every second or third year, depending on the need in the future.
Two additional hydrological technicians should therefore be identified as soon as possible, and suitable training programmes should be implemented in accordance with their qualifications. The details of the training programme will also depend on which type of instrumentation is selected for the various hydrometric stations. In general, however, it is envisaged that the hydrometric network in Timor-Leste will be established in cooperation with a "twinning" organization in a donor country, and a small part of the training will be carried out in the donor country and the country where the hydrometric equipment is purchased, while the major part should be on-the-job training in Timor-Leste.

Since the education of a professional hydrologist and a meteorologist/climatologist will take several years, it is also recommended to engage a professional expatriate hydrologist for a period of minimum 2 years, but preferably for 5 years. One of the major duties of such a hydrologist will be to carry out extensive training programmes in water resources monitoring and data analyses, as well as train the observers in the field.

Since the new database HYDSTRA will be installed in the ALGIS-unit, the need for additional HYDSTRA-, GIS-, or general computer training should continuously be evaluated, in accordance with the future size of the unit and external needs for GIS- or database services.

<u>The Team recommends:</u>

1 hydrologist and 1 meteorologist or climatologist to be identified by the Government and appointed for university studies abroad as soon as possible.
2 hydrological technicians to be identified by the Government and appointed for a 3 week <u>initial training/familiarization</u> course abroad as soon as possible.
All further training, except for formal <u>education, is best done in-country and on-the-job, under local conditions, rather than overseas.</u>
Such training is the most economic, as several people can be trained simultaneously.
Continous evaluation of capacity and training needs in the ALGIS-unit.

6.3 *Specific equipment*

6.3.1 The need

Non-standardized instrumentation and lack of co-operation between donors as well as between ministries and departments have been a severe constraint in the development of water resources monitoring in most developing countries. The introduction of high-tech instruments have also been a problem, where capital and technology intensive approach is very risky.

Technologically advanced equipment should therefore be introduced only at a rate which can be assimilated by the individuals, organisations and, in particular, the data management system concerned. Sophisticated instrumentation and software do not operate without problems. In a tropical and humid climate like in Timor-Leste, electronic field instruments are likely to require so much servicing and replacements of parts after a few years that it is uneconomic to maintain, and results in so much missing records that data quality is severely compromised. This is particularly the case with instruments at remote field stations that are exposed to moisture (rainfall and water level recorders). If electronic data recording is necessary, a manual back-up nevertheless is advisable, to fill in missing records.
A number of major advantages by using manual observations can be listed:

- Data quality assurance.
- Missing records due to instrument failure and malfunction is minimized (spider's web in tipping-bucket rain gauges, etc.)
- The people that manage the data understand what the observations actually mean – downloading and processing of electronic data tends to remove the incentive to actually examine and understand the observations, observe patterns and trends, etc.
- Security is enhanced, particularly for observing stations at remote sites, where local residents are paid a small fee to make observations and ensure that instruments are secure and maintained to specification.
- Sustainability and economy of the water resources monitoring system is achieved long-term – a daily-read rain gauge will continue to provide data indefinitely, while an automatic gauge will most probably only last for 5 – maybe 10 – years before it needs capital for replacement (ie. less sustainability).

Last, but not least, every effort should be made to standardise instrumentation, software, and data management procedures, both within and between organisations.

> ***Standardization of equipment:***
>
> ***Standardization of equipment, software and data management procedures are essential for a sustainable water resources monitoring system***

6.3.2 Short term – long term

It is of crucial importance that a phased approach is taken when establishing a water resources monitoring system in Timor-Leste, with introduction of technology (hardware, software, and data management system) at a rate that can be assimilated by the individuals and organisations concerned. At each phase, the monitoring system should demonstrably be delivering the required information to pre-determined quality standard, before moving to the next phase.
In the first phase, which should last for 2 years, 5 water level stations should be established (Figure 6.1), while the existing station at Iralalaru should be rehabilitated and equipped with standard instruments.

> ***The Team recommends that:***
>
> ***50 manual rain gauges be installed troughout the counytry, and***
> ***2 tipping bucket rain gauges be installed (mostly for training purposes), and***
> ***5 water level stations be installed at selected rivers.***

Figure 6.1 Proposed locations for hydrological stations in Timor-Leste

During this phase 50 rain gauges should be established throughout the country, in accordance with international guidelines as prepared by the World Meteorological Organization and indicated in an ADB report [4]. If possible, these stations should be established at former locations where rainfall stations were operated during the Portuguese period [2]. ADB is proposing that all rain gauges should be automatic, i.e. tipping bucket rain gauges. With reference to chapter 5.2.1, it is strongly recommended that all 50 rain gauges are manual. It is suggested, however, that the 50 rain gauges are supplemented by 2 tipping bucket rain gauges mainly for training purposes, but also to get some indication on rainfall frequency, intensity and duration.

An extension of the hydrometric network in accordance with the ADB proposal should only be decided upon after 2 years (long-term).

6.4 Hydrometric Stations

Careful map studies and two short field reconnaissance trips have been carried out, in order to identify suitable locations for a minimum hydrometric network. Out of former hydrometric stations only two have been identified, the one at Iralalaru (Figure 6.2), and one at Gleno (Figure 6.3) [7]. The latter one is in a very poor condition and will need thorough rehabilitation in order to provide reliable data.

Figure 6.2 The existing water level station at Iralalaru.

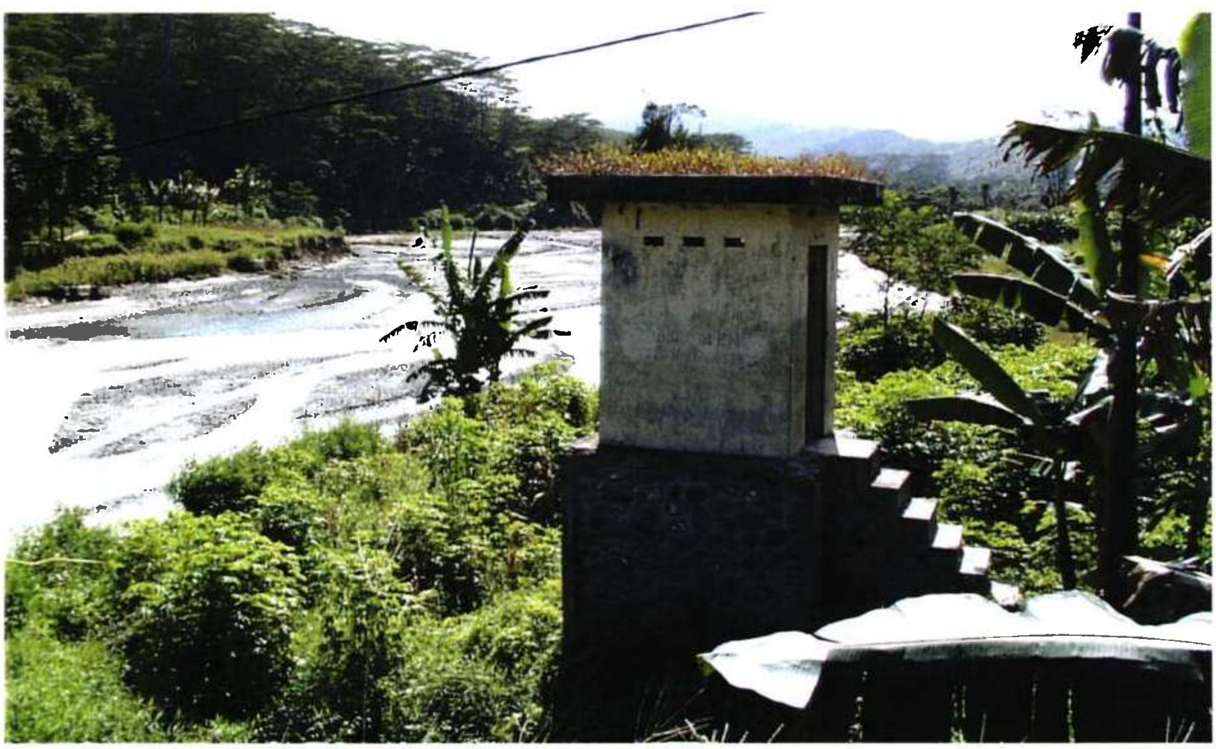

Figure 6.3 The old water level station at Gleno.

Timor-Leste is a mountainous country with fairly high erosion in many of the catchments. The result is high sediment transport and braided rivers after meeting the lowlands. Good and reliable locations for gauging stations covering larger catchments are therefore scarce.

Establishing high quality and reliable stations in the lowlands normally means high investments in artificial weirs for stabilizing the control, which is not even always a good solution in such a dynamic landscape as Timor-Lestes'.

Examples of such stations are the one at Gleno (Figure 6.3) and the bridge on the road from Ainaro to Hatuodo, crossing the Mota Belulic (Figure 6.4). The latter one would be an ideal station for monitoring the runoff from the highest mountainous and rainfall area in Timor-Leste towards the south, but would need high investments in a hydrometric station. Some smaller tributaries in the upper parts of the Mota Belulic catchment were therefore investigated, and several suitable station locations were found (Figure 6.4). The most suitable location for a water level station is probably at Mota Tolemau, as shown in Figure 6.5.

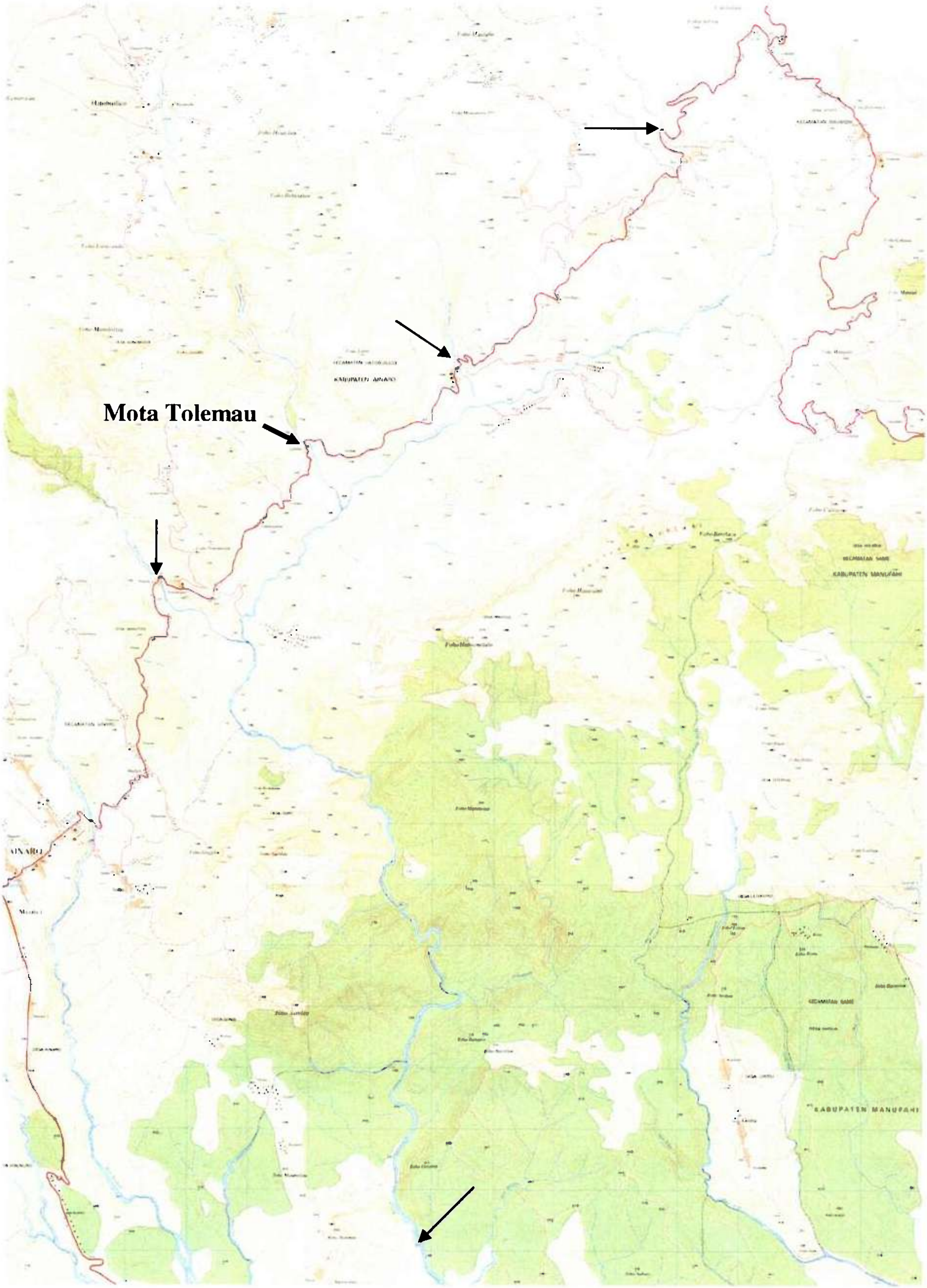

Figure 6.4 Identified locations for hydrometric stations in the Ainaro area. The lowest arrow indicates the road bridge from Ainaro to Hatuodo, while all the upper arrows indicate good locations for hydrometric stations.

Figure 6.5 The road bridge across Mota Tolemau

In Phase 1 it is suggested to establish three new water level stations, in addition to the existing one at Ira Lalaro and the one to be rehabilitated at Gleno, ie. a total number of 5 stations, as indicated in the table 5.1.

Hydrologic Unit	Major Catchment	River	Area (km^2)	Location of station
Clere & Belulic	Belulic	Tolemau	~30	Road bridge across Mota Tolemau
Irabere	Cuha	Cuha	~200	Road bridge at Buanurak
Vero	Iralalaru	Irasiqira	383	Ira Lalaro
Loes	Loes	Gleno	~90	Gleno (Road bridge)
Laclo	Middle Laclo	Manufonihun	190-200	At proposed damsite

Tab. 5.1 Proposed new hydrometric stations in Timor-Leste in prioritized order.

At Buanurak upstream of Viqueque where the main road crosses the Mota Cuhan there is an artificial weir which provides a stilling pool for the water level registration. (Figure 6.6)

Figure 6.6 Proposed location for a new water level station at Buanurak

It is further proposed that the station at Buanarak is equipped with double instrumentation (one chart-recorder with a float, and one data logger with pressure transducer) for training purposes.

A provisional runoff station was established at the proposed damsite in Manufonihun River, a tributary to the Laclo River, in 2004 [3], and continuous runoff records have been obtained since then. Laclo is one of the largest rivers in Timor-Leste, and a permanent station should be established. The present station gives fairly reliable data, however, and considering the remoteness, the river should therefore have the lowest priority in Phase 1. With reference to the proposed stations at Iralalaru and Gleno the reader is referred to [7].

The ADB has proposed 10 to 15 stations to be installed as part of a national network. The ADB further proposes that the selection of stations should be based on a large number of discharge measurements carried out in a large number of river during the dry season as well as the wet season, and analyses of these measurements. The proposed stations in this report are not in contradiction with the ADB proposal, since all proposed stations are in line with the recommendations in [4]. In order to carry out the recommended discharge measurements and the following analyses an experienced hydrologist should be based permanent in Timor-Leste, however, and the field work and the analyses should be part of a continuous training program of national staff. The establishment of the 5 stations will also be part of such a training programme. The extension of the hydrometric network in phase 2 (long term) should follow the ADB proposal as much as possible, but it is strongly recommended, based on extensive experience from a number of developing countries, to move slowly and put a lot of emphasis on training and education, and involve all water users, in order to provide sustainability.

The Team recommends:

Move slowly, step by step, and make sure that implementation is accompanied by proper training and education, and all water users are informed and involved, in order to facilitate sustainability and successful IWRM

6.5 Hydrological equipment

With regard to hydrological equipment it is suggested to purchase most of the equipment from Hydrological Services PTY (HS) in Sydney. Their equipment has been widely used in Australia and many Asian countries, and has proven its functionality in hot and humid climates. In addition the company has a setup of very good and high standard training facilities at their factory outside Sidney.

As a preliminary choice is suggested to purchase the RRDL3-AN-LCD data logger, which is a multi-channel logger (Annex 3). As such it can also be used for tipping-bucket rain gauges, if it is at a later stage decided to move from manual rain gauges to automatic ones. As sensor it is suggested to purchase the WL1000 pressure sensor as standard (Annex 3). It should be considered if the water level stations should be equipped with double instrumentation; one automatic set and one manual set. At least one of the stations should be equipped with double instrumentation for training and educational purposes, however.

Careful consideration should be done with regard to selection of rain gauges. Manual rain gauges are produced by a number of companies throughout the world, with small variations in quality. It is suggested to check out a manual rain gauge produced by Nanjing Automation Institute (Ministry of Water Resources) in China and one raingauge from HS.
With regard to tipping bucket rain gauge it is suggested to purchase the HS305 model from HS (Annex 3).
One additional current meter (already one in Timor-Leste) should be purchased (Annex 3), in order to equip two field teams which can then operate independently. In addition one can be used for training purposes, and both current meters should at least be calibrated once every second year in Australia. Some additional equipment will be necessary for the data retrieval (Annex 3).

6.6 Groundwater and water quality monitoring

Groundwater as well as water quality is part of a hydrometric network and integrated water resources management. With limited resources, however, it was at this stage considered more important to focus on surface water. With increasing demand for clean water for various purposes the groundwater and water quality will be increasingly more important, and close cooperation between the various ministries and departments will be necessary. This fact should be taken into account when considering future organisational structures within the Government.

The ADB TA guidelines recommend that 10 to 15 groundwater monitoring stations (boreholes or wells) be installed as part of a national network. This is similar to the number of recommended streamflow monitoring stations and recognises the present and increasing future importance of groundwater to the nation. It is noted that there is no recommended minimum density for groundwater monitoring stations or sites in WMO (1994) guidelines.

The recommended number of stations does not take account of specific purpose or 'project' stations including the groundwater pumping bore holes or wells used for water supply for Dili and Suai.

7 Other issues

The contract agreement between NVE and MTCPW defines the objectives and activity plans for 2005 as outlined in the minutes from the Annual Meeting 25st January 2005.

The activities are accomplished according to the plan. The team discussed the different activities and some items shall be followed-up from Norway.

ADB has initiated implementation of IWRM by preparing several draft documents in addition to activities to raise the awareness of water. The ADB assistance will probably focus more on water supply and sanitation service delivery.

Annex 1

Terms of Reference for the Team

16.09.2004
Revised version 13.03.2005

TERMS OF REFERENCE
FOR
HYDROLOGICAL MISSION TO
TIMOR-LESTE

Preparation to establish a Hydrological Unit in Timor-Leste, arrange training courses and propose future education programme within hydrology and recommend purchase of hydrological equipment for the Ministry of Transport, Communication and Public Works, Timor-Leste.

1. Introduction:

The Ministry of Transportation, Communication and Public Works (MTCPW) of Timor-Leste and the Norwegian Water Resources and Energy Directorate (NVE) have in February 2003 entered into an agreement on institutional cooperation for support from NVE to strengthen the Energy Sector in Timor-Leste. The support shall include establishment of a hydrological network, improve the data collection, handling and analysis in the hydrology sector and advise on additional equipment to be purchased. A Hydrological Unit within the governmental sector should be established, for servicing all users of water and facilitating integrated water resources planning and management. The proposed services from the NVE team are a part of this agreement.

2. Objective:

The objective of this mission service is to propose a structure and organisation for a Hydrological Unit in Timor-Leste, propose a manpower development plan within hydrology, and recommend purchase of hydrological equipment for the hydrological network to be established in Timor-Leste. Particular attention should be given to future cooperation between hydrologists, meteorologists and climatologists. A firm recommendation for establishment of a primary network of hydrological stations shall be made, keeping in mind all users of water. Particular emphasis should be given to hydropower, water supply and irrigation.

3. Mode of work:

The team shall travel to Timor-Leste and carry out the work there. The team shall familiarize themselves with previous reports on water resources and energy demand in Timor-Leste. The team shall cooperate closely with the staff at the Ministry of Transport, Communication and Public Works,(MTCPW) , other involved Ministries, EDTL, ADB and other relevant institutions to secure that a functional Hydrological Unit is established within the Governmental system, that training can be carried out as efficient as possible, and that the necessary equipment to be purchased are standardized and accepted also among the other parties involved within the water resources sector.

4. Scope of work:

The team's work shall consist of the following issues:

Propose a Hydrological Unit in Timor-Leste.

The team shall propose the staffing of the Hydrological Unit, including the necessary educational background of the staff.

The team shall propose where in the Governmental system the Hydrological Unit shall be located (propose organisation chart).

The team shall propose a capacity building/educational program for the staff, where necessary. The program should also include operation and maintenance of purchased equipment.

The team shall, after discussion with the other involved parties, propose necessary equipment to be purchased in order to establish a minimum and specific purpose hydrometric network for Timor-Leste.

The team shall, based on field reconnaissance, recommend areas, and if possible, sites to construct the hydrometric stations.

The team should carry out two courses, respectively on hydrometric network establishment and on integrated water resources management, with particular emphasis on Timor-Leste's conditions.

5. Time schedule:

The work shall be carried out within April 2005. Any changes shall be agreed upon between NVE and the MTCPW in writings.

The report from the team shall be prepared and mailed to MTCPW within 3 weeks after the mission is completed.

Annex 2

Participants in meetings and workshops

Participants Information Meeting 06.04.2005:

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Charles Bonhomme, repr of French Embassy, Timor-Leste
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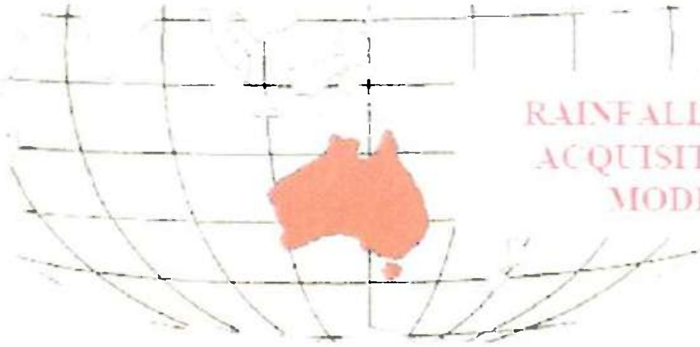
Annex 3

Proposed hydrometric equipment

Bulletin 28
Edition 3



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- Protection On Inputs & Outputs
- Low Power Operation
- Fully Environmentally Tested
- Programable Alarms
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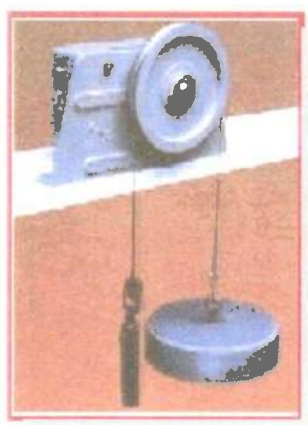
- LCD Digital Display (Some Models)



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DESIGNED AND MANUFACTURED
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The HYDROLOGICAL SERVICES RRDL3 - Rain and River Data Acquisition System is a compact, programmable acquisition device suitable for any short or long term remote data loggin application. The powerful communication interfaces and software enables the RRDL3 to alarm dial external phone numbers or to send data via radio, satellite or telephone modem. Alternatively a status report can be generated and transmitted on request.

Available Models:

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- Rain Quadrature shaft encoder
- Rain Quadrature built in shaft encoder
- Logger upgrade kit to fit all H.S. quadrature shaft encoder

2- RRDL3-AN Data Logger. Durable ABS case.
- Rain River Gas Purge System

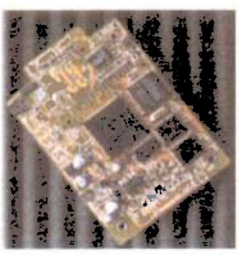
3- RRDL3-AN-HC Data Logger. Hard Aluminium Case with Mill Spec Connectors. No LCD Display
- Rain River Gas Purge System

4- RRDL3-AN-LCD Data Logger. Hard Aluminium Case, with LCD Display and Mill Spec Connectors
- Rain River Gas Purge System

COMMUNICATION:

An RS - 232 Serial Port allows direct communication with a computer on-site or remote via a modem link (for radio, satellite or telephone).

Communications are two-way so that the RRDL3 can be remotely interrogated to send a status report, download all or part stored data. Alternatively, it can be programmed to automatically dial out to 3 preset phone numbers based upon reaching alarm or trend levels. It can also be programmed to send scheduled messages for river height and rainfall.



All operating parameters can be programmed remotely via a computer and modem. On line HELP instructions are available for every logger command. A full status report on all operating parameters and the battery is available on interrogation.

POWER CONSUMPTION:

All RRDL-3 are low power usage devices. However, the power consumption differs between one model and another. All loggers power up when an event is recorded or a programmed timed analogue reading is initiated. In sleep mode the power consumption for each model is as follows:

a) *RRDL3 Data Logger:* sleep mode 150 µA. 6 x AA cells provide a power sufficient for up to 12 months operation.

b) *RRDL3-AN/ RRDL3-AN-HC Data Logger:* sleep mode 0.5mA. 1x 12VDC, 7 Amp Hr battery provide a power sufficient for up to 4 months operation.

c) *RRDL3-AN-LCD Data Logger:* Sleep mode 3.0 mA. 1x 12VDC, 18 Amp Hr battery provide a power sufficient for up to 4 months operation.

DATA LOGGER MODEL RRDL3

OPERATION:

MODEL RRDL3 is a rugged, compact data logger for use with Hydrological Services Tipping Bucket Raingauge and Quadrature shaft encoder. This unit records the date and time of occurrence of tips from the tipping bucket raingauge or the ± encoded signals from a shaft encoder up to 52,000 events able to be stored in the RRDL3's memory. The data is stored in a 128KB Flash EPROM.

The Model RRDL3 is optically isolated smart sensor interface. It fits inside the model TB3 Raingauge or is housed as a free-standing data logger. The compact design of the RRDL3 makes it ideal for incorporation into any piece of equipment where intelligent data acquisition and logging are required.

SPECIFICATIONS:

Microprocessor:	Intel 80C196.
Program memory:	AMD29F010 128kb Flash EPROM (PLCC28) 64 kb Available for Program
Data Memory:	AMD29F010 128kb Flash EPROM (PLCC28)
Parameter Memory:	PCF8594 512 Bytes EEPROM (SO8) (Min of 100,000 erase rate cycles)
Events Recorded:	1 second resolution. Two Partition Memory: User Select

Large Partition **Small Partition**

a) 40,000 Digital rain events + 16,000 river events

Or

b) 16,000 river events + 40,000 Digital rain events

Real time clock:	day month year / hour minute second. Battery backed withLithium Cell 32768 Hz crystal trimable Accuracy 20 secs per month Programmable alarm wake up.
Input:	1x digital raingauge input / 1 x Digital Quadrature Shaft Encoder input Optically Isolated expansion port for smart sensors - 4-20 mA, 0-5V etc

Output:	1x O/C output for sensor 1x batt Switched output for modem power
Operating Temp Range	-30°C To +60°C
Humidity	100% Condensing
Housing	Durable ABS IP65
Communications:	RS232 port [TX, RX, DTR AND CD] Hardware handshake or XON/XOFF. Mini modem power control. Direct input and control of INMARSAT Mini 'M' Sat phones
Power Supply	6V to 14V DC unregulated. 65mA operating mode. 150 A sleep mode.
Transient Protection	Each input protected to 500V DC at 20 joules W.R.T. 0V
Dimensions	123mm X 80mm X 55mm, 0.4Kg
Packed Details	0.6 Kg, 0.001m³
Help:	Unique on board help system to give available commands as well as individual command description and syntax

AVAILABLE MODEL CONFIGURATIONS:

RRDL-3 - Rain Quadrature shaft encoder input
RRDL-3Q - Rain Quadrature built into shaft encoder
KQ-1 - Logger upgrade kit to fit all H.S. quadrature shaft encoders
- Communications & alarm software for all models

DATA LOGGER MODEL RRDL3-AN & RRDL3-AN-HC

The differences between the RRDL3-AN and RRDL3-AN-HC are the Cast Aluminium case and the Mill spec plugs that the model RRDL3-AN-HC possesses.

RRDL3-AN

RRDL3-AN-HC

OPERATION:

MODEL RRDL3-AN RRDL3-AN-LCD is a rugged, compact data logger for use with Hydrological Services Tipping Bucket Raingauge and Pressure Transducers. This unit records the date and time of occurrence of tips from the tipping bucket raingauge and the analogue inputs from 4 - 20 mA, 0 - 5 volts or 0-100 mVolts transducers with up to 52,000 events able to be stored in the RRDL3's memory. The data is stored in a 128KB Flash EPROM.

SPECIFICATIONS:

Microprocessor	Intel 80C196.
Program memory:	AMD29F010 128kb Flash EPROM (PLCC28) 64 kb Available for Program
Events Recorded:	1 second resolution: Two Partition Memory, User Select

Large Partition **Small Partition**

a) 40,000 Digital rain events + 8,000 Analog river events
Or
b) 20,000 Analog river events + 16,000 Digital rain events

Real time clock:	day month year hour minute second.
Inputs:	1x digital raingauge input, 1 x analogue (4-20mA, 0-5V, 0-10V or 0-100mV)
Output:	1x O/C output for sensor. 1x batt Switched output for modem power
Operating Temp Range:	-30°C To +60°C
Humidity	100% Condensing
Communications:	RS232 port [TX, RX, DTR AND CD] Hardware handshake or XON/XOFF. Mini modem power control. Direct input and control of INMARSAT Mini 'M' Sat phones.
Power Supply	12V to 14V DC unregulated. 80mA operating mode: 0.5mA sleep mode.
Transient Protection	Each input protected to 500V DC at 20 joules W.R.T. 0V
Dimensions	120mm X 80mm X 55mm, 0.4Kg (RRDL3-AN) 140mm X 140mm X 80 mm 1.1Kg (RRDL3-AN-HC)
Housing	Durable ABS, IP65 (RRDL3-AN) Diecast Aluminium, IP65 (RRDL3-AN-LCD)

Help: Unique on board help system to give available commands as well as individual command description and syntax.

Analogue P.C.B.: Sensor power up selectable 1 to 9 seconds. Transducer reading interval 1 to 99 minutes

Calibration: On board microprocessor, 16 bit resolution. Temperature compensated. Zero drift compensated. Accept up to 24 inputs

DATA LOGGER MODEL RRDL3-AN-LCD

OPERATION

The RRDL3-AN-LCD is the top of the range data logger. It possesses the manual initiation of level reading and LCD activation via push button.

Model RRDL3-AN-LCD is a rugged, compact data logger for use with Hydrological Services Tipping Bucket Raingauge and Pressure Transducers. This unit records the date and time of occurrence of tips from the tipping bucket raingauge and the analogue inputs from 4 - 20 mA, 0 - 5 volts or 0-100 mVolts transducers with up to 52,000 events able to be stored in the RRDL3's memory. The data is stored in a 128KB Flash EPROM.

SPECIFICATIONS

Microprocessor: Intel 80C196

Program memory: AMD29F010 128kb Flash EPROM (PLCC28) 64 kb Available for Program

Events Recorded: 1 second resolution. Two Partition Memory. User Select

Large Partition **Small Partition**

a) 40,000 Digital rain events + 8,000 Analog river events.

Or

b) 20,000 Analog river events + 16,000 Digital rain events

Real time clock: day month year hour minute second

Inputs: 1x digital raingauge input. 1 x analogue (4-20mA, 0-5V, 0-10V or 0-100mV)

Outputs: 1x O.C output for sensor
1x batt Switched output for modem power

Operating Temp Range: -10°C To +60°C

Humidity: 100 % Condensing

Displays: LED indicator to show a change has been recognised / logged. 4 line, 20 character high temperature LCD display.

Communications: RS232 port [TX, RX, DTR AND CD] Hardware handshake or XON/XOFF. Mini modem power control. Direct input and control of INMARSAT Mini M Sat phones.

Power Supply: 12V to 14V DC unregulated. 80mA Reading mode for 15 seconds. 3.0 mA sleep mode

Transient Protection: Each input protected to 500V DC at 20 joule W.R.T. 0V

Dimensions: 140mm X 140mm X 80mm. 1.1Kg

Housing: Cast aluminium. IP65 rated.

Help: Unique on board help system to give available commands as well as individual command description and syntax.

Analogue P.C.B.: Sensor power up selectable 1 to 9 seconds. Transducer reading interval 1 to 99 minutes

Push Button: Manual initiation of level reading and LCD activation via push button.

Calibration: On board microprocessor, 16 bit resolution. Temperature compensated. Zero drift compensated. Accept up to 24 inputs

ACCESSORIES

RRDL3 & RRDL3-AN

1 Connecting lead to modem. DL309
2 9 pin interrogation lead. DL306
3 25 pin interrogation lead. DL308
4 Communications software. DL312

RRDL3-AN-HC & RRDL3-AN-LCD

1. Connecting lead to modem. DL309-AD
2. 9 pin interrogation lead. DL306-AD
3. 25 pin interrogation lead. DL308-AD
4. Communications software. DL312

Note: Specifications are subject to change at anytime without notice

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SUBMERSIBLE PRESSURE TRANSDUCER
MODEL WL1000 W
• Water Level Monitoring and Recording
• High Accuracy ± 0.05 % F.S.
• Precalibrated Sensor
• Temperature Compensated
• Thermally Preconditioned
• Output Signals
- 4 to 20 mA, 2 Wire System
- 0 to 5V
- 0 to 250mV Differential
• Borehole Model Available
ISO 9001
QUALITY SYSTEM CERTIFIED
HYDROLOGICAL SERVICES PTY. LTD.
Hydrological Instruments & Equipment
Designed & Manufactured By Hydrologists

The Hydrological Services WL1000W is our latest generation of wet pressure transducers.

It incorporates Hydrological Services latest technical innovations. It allows the measurement of water head to a fine degree of accuracy and repeatability.

The unit consists of a strain-gauge bridge sensing element fitted to a housing both of which are Type 316 Stainless Steel. The electronic circuitry is contained within a factory sealed housing. The electrical connection is made via a multicore vented submarine cable.

Transducer housing can be either standard or borehole, both of which are made of 316 stainless steel. The borehole housing is longer than the standard to provide additional mass and ensure that the cable hangs straight and will not creep after initial installation.

WET PRESSURE TRANSDUCER MODEL WL1000W OPERATION

Current Loop Model

The electrical output is a standard 4mA to 20mA 2-wire current loop, with the Red wire being for the Positive excitation and the Blue wire being the return. The output is compatible with any recording device that has an excitation voltage source and a 4-20mA current loop input, ie. Data Loggers or RTUs, for example, provided that the voltage at the WL1000W tranducer is within the specified range (9 Volts to 30 Volts) for all values of loop currents (4mA to 20mA).

Voltage Output Model

The electrical output is via 2 wires either single-ended 0-5Volt or a differential 0-250 mV. The output is compatible with any recording device that can accept a 0-5 Volt input or 0-250 mV differential input respectfully.

Power to the tranducer is via another 2 wires for supply and ground. Nominal supply voltage is 12 Volts (10V to 14V).

All units are factory calibrated over their full operating range on our 45 metre Calibration Bore. A calibration certificate is supplied with each Sensor.

Isolation Diaphgram	316 Stainless Steel	
Operating range:	From 5 metres to 50 metres	
Overpressure:	2.67 x ranges	
Supply Voltage:	**Current Loop Model** 9 - 30V DC **Voltage Output Model** +12V Nominal (10V to 14V D.C)	
Output Signal:	4 to 20 mA 0-5V 0-250mV differential	
Overall Accuracy:	± 0.05% full scale	
Long Term Stability:	Typically ± 0.05% F.S./annum	
Operating Temperature range:	-20°C to +60°C	
Humidity:	100%	
Electrical Connection:	four wires stripped, twisted and tinned	
Junction Box:	black delrin housing (37.5mm diameter x 75mm long) locks kevlar strands, termination for vented cable with hydrphobic filter, eight pin bayonet socket for electrical connection with 1 metre long mating lead. Provision for wall mounting.	
Vented cable:	6 core vented polyurethane with kevlar strength members. 1 metre supplied as standard *additional available as requested*	
Voltage Spike Protection:	Units will withstand a 600V Voltage spike in accordance with ENV 50142 without damage when applied between all excitation lines and case	
Calibration:	Over full range against water head	
Insulation:	Greater than 100MΩ at 500 V d.c.	
Dimensions:	Standard Length - 200 mm Diameter 21 mm	Borehole Length-380 mm Diameter-21 mm
Mass:	400 g	700g
Packed Weight:	0.5 kg	0.8 kg

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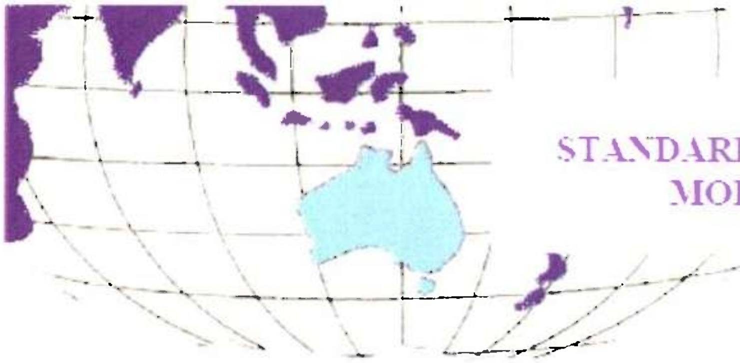


Bulletin 47
Edition 1

STANDARD RAINGAUGE
MODEL SRG

- Measure Rain with an Increment of 0.2 mm
- Corrosion Resistance
- UV Resistant
- 300 mm Collector Capacity
- Easy to Install and Maintain

ISO
9001

QUALITY SYSTEM
CERTIFIED

HYDROLOGICAL SERVICES PTY.LTD.

HYDROLOGICAL INSTRUMENTS & EQUIPMENTS
DESIGNED AND MANUFACTURED
BY HYDROLOGISTS

Description

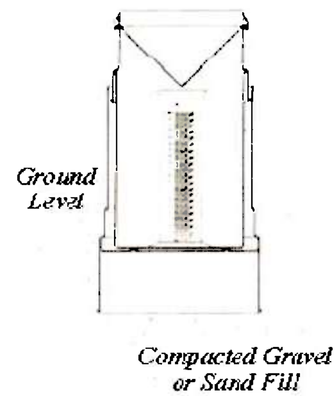
The Hydrological Services Standard Raingauge model SRG is recognised as the standard non recording type raingauge. The Raingauge is fully constructed from Aluminum except for the rain measure which made out of durable plastic and has a capacity of 20 mm of rainfall. The overflow of rain is collector by raingauge collector which has a capacity of 300 mm of rainfall.

It is recommended that the gauge be read daily at a fixed time (preferably 9:00 am) after a rainfall event, to the nearest 0.2 mm of rainfall. The reading is taken by simply lifting the catch from the gauge, allowing access to both the collector and rain measure.

In the event of heavy rainfall where greater than 20mm of rain has fallen, the rain measure will overflow into the collector. To measure this large amount of rainfall it is simply a matter of pouring from the collector into the rain measure and totaling the amounts.

Installation

After selecting a suitable site, it is necessary to dig a hole approximately 300mm diameter and 230mm deep. Then a 50mm bed of compacted fine gravel or coarse sand is placed in the bottom of the hole. The following step is to place the enclosure in the hole and check for level, then backfill with gravel or sand, compact the fill and recheck level. Ground level should be at the second ridge on the outer enclosure (see figure below).



Once done, the collector is positioned in the outer enclosure, followed by the rain measure which is positioned centrally in the collector and then the catch onto the collector.

Specification

Material:	Aluminum Powder Coated APO Grey
Catch:	203mm Dia. (8 Inch)
Collector Capacity:	300mm of Rainfall
Rain Measure Capacity:	20mm of Rainfall with smallest increment of 0.2mm
Packed Dimension:	560 x 300 x 300 mm
Packed Weight:	4 kg

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HYDROLOGICAL SERVICES PTY LTD

Tipping Bucket Rain gauge
Model HS305

Description:

The Hyrological Services Tipping Bucket Rain gauge is recognised as the standard for measuring rainfall and precipitation in remote unattended locations. The integrated syphon mechanism delivers high levels of accuracy funnel with steel leaf sieve, an integrated siphon control mechanism, an outer enclosure with quick release fasteners, and base which houses the tipping bucket mechanism. The unit includes dual out out reed switch with Varistor protection as well as dual rainfall discharge outlets for water collection and/or analysis. Insect screens are fitted to all outer openings. The bucket tips when precipitation of 1.0mm has been collected. Each tip is marked by a reed switch closure and stored to a Data Logger and / or used by Telemetry System.

Model HS-305 has been specifically designed to suit the ALERT Flood Warning System. The Receiver is 305mm in diameter and the bucket tips each 1.0mm of precipitation.

ACCESSORIES:
Rainfall Data Logger - Model RRDL-3 (to view this product, please view the specific section for this product within this website).

Rainfall Sentry - Model RS-3 (to view this product please view the specific section for this product within this website).

Figure: HS305

Specifications:

Reciever: 305mm+/-0.3 diameter width machined aluminuim rim

Sensitivity: One tip at 1.0mm

Measuring Range: 0-700 mm/hr

Calibration: +/-2% 25-500 mm/hr, long term stables calibration

Sensor: Tipping Bucket with Syphon

Contact System: Dual Reed Switchs, potted in Silicon Rubber with Varister protection

Contact Capacity: 12VA, 0.5 amp max.

Contact Time: 0.1Second

Height: 505mm

Weight: 5.6kg

Bucket: 1mm Synthetic Ceramic coated Brass

Packed Dimensions: 9kg, 0.07metres cubed

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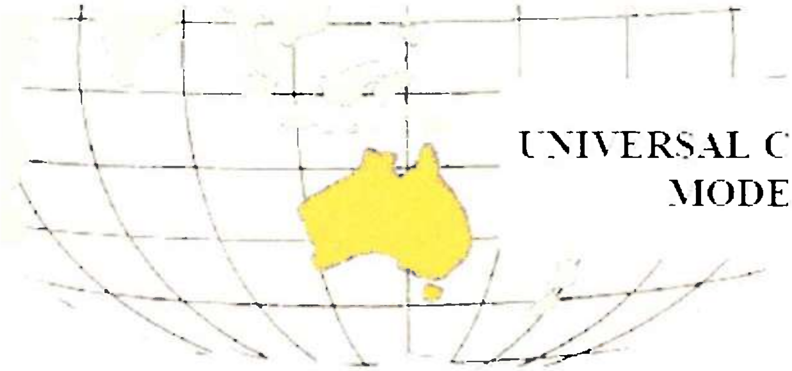
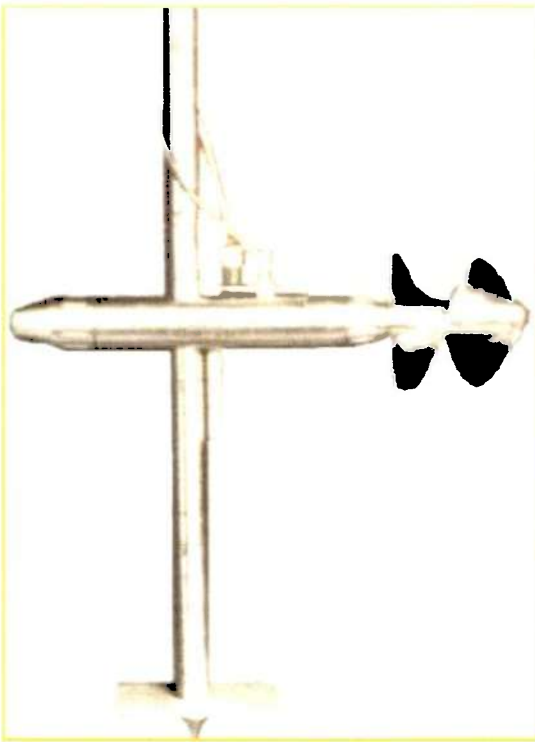


UNIVERSAL CURRENT METER
MODEL OSS-B1



Universal Current Meter
Model OSS-B1

- Streamline, Robust Stainless Steel Body and Axle
- Stainless Steel Propellers, 4 Sizes
- **Non Contact Switching System-Permanent Magnet and Reed Switch**
- **Minimum Starting Velocity: 0.025m/sec**

ISO 9001

QUALITY SYSTEM CERTIFIED

HYDROLOGICAL SERVICES PTY.LTD

HYDROLOGICAL INSTRUMENTS & EQUIPMENTS
DESIGNED AND MANUFACTURED
BY HYDROLOGISTS

DESCRIPTION

The OSS B1 Universal current Meter is a world recognized designed instrument for measuring the velocity of water in rivers, streams, open canals, pressure pipes, lakes and seas. Made of Stainless Steel, the OSS-B1 is suitable for even the most extreme environments and ensures reliable field services for many years.

OPERATION

The OSS B1 current Meter consists of streamlined body which houses the sensing mechanism, an encapsulated reed switch, and the propeller shaft, which has a permanent magnet, mounted such that each rotation of the shaft produces a pulse from the reed switch. The pulses are conducted through a lead to the surface where they are counted by a current meter Counter. The velocity of the stream is proportional to the rotations of the propeller. The following equation is used to calculate the velocity

$V = K \times N + a$

Where: V *Velocity*
K *Hydraulic pitch of the propeller*
N *Number of pulses counted*
a *A constant determined by ration tests*

Each OSS B1 is provided with a calibration in accordance with AS 3778.6.3-1992 ISO 3455-1976. A calibration certificate and rating tables are provided.

FEATURES

The OSS-B1 superior design offers:

1. Stainless Steel construction to resist corrosion and damage.
2. Ease of replacement of the Reed Switch Assembly.
3. Rubber encapsulation of the Reed Switch to resist damage from dropping or knocking.
4. Heavy Duty Pelican case with moulded foam.
5. Relocating Device for in stream adjustment of the current meter mounted on the wading rod.
6. "Hockey Stick" style Sewer Rod to position meter in pipe for man hole.

OPTIONAL CONFIGURATIONS

Three options are available for locating the OSS-B1 in waterways ranging from low to very high flow rates.

Option 1. The standard configuration is supplied with 3x1m sections of 20mm diameter Stainless Steel rod for locating in shallow to medium depth streams or rivers. The rod is graduated every 2cm and dm. A point and base plate is used to position the rod in the river or stream bed. A relocating device is available to allow the OSS-B1 to be relocated along the rod without having to withdraw the rod from the stream. This allows the user to continuously observe velocities at different depths of the stream.

Option 2. A Streamlined Suspension tube is available for suspending the OSS-B1 in a fast flowing stream up to 5 Meters in depth. The Streamline Suspension Tube is shaped like a wing and provide greater support against the stream flow. A stand and Clamp are available for supporting the Streamlined Suspension Tube and OSS-B1 from bridges or other fixed structures.

Option 3. A Stabiliser tail fin (CMB09) is attached to the rear of the meter when it is mounted on a hanger bar attached to a Columbus weight: 7, 14, 23, 34, 45, 68, 90 or 135Kg. This assembly is suspended from a gauging winch with an armoured signal cable. Alternatively the OSS-B1 can be mounted on the nose of a 25Kg or 50Kg Nose Mounting Ground Feeler weight and suspended from a gauging winch.

CURRENT METER COUNTERS

The OSS-B1 provides a pulse to a Current Meter Counter. Hydrological Services offers two counters to suit all applications. All models records up to 40 pulses per second.

HydroMate is the top of the range counter with direct velocity reading functionality, more details please refer to bulletin (5).

CMC20A is a complete counter which can be set to count pulses for a specific time period (10-200 secs). The counter stops when the time period has elapsed and shows a digital reading for the number of pulses.

HydroMate

CMC 20A

SPECIFICATIONS

The OSS-B1 is supplied in a basic kit as follows:
Propeller type A, 4 m Connecting Lead, Tools, Oil, Spare Bearings, Spare Reed Switch Assembly, 3x1m, 20 mm diameter rods (in canvas carry bag), point and base plate, Calibration table and Carry Case. Optional Items can be added.

Propeller specifications:

Type	Size	Max Velocity m/s	Start Velocity m/s	Range of Component Effects
A	100mm x 0.125m	5.0	0.025	= 45°
1	125mm x 0.25m	10.0	0.025	= 5°
2	125mm x 0.50m	10.0	0.040	= 5°
4	80mm x 0.125m	4.0	0.040	= 5°

Packing Dimensions: 22Kg, 0.05 m^3

Note: Specifications are subject to change at anytime without notice

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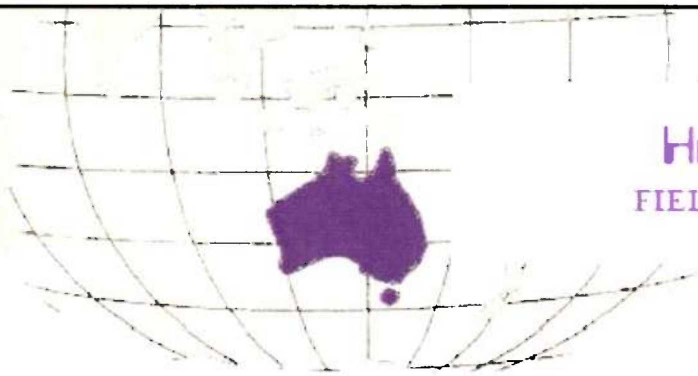
Bulletin 5
Edition 5



HydroMate
FIELD COMPUTER

SOFTWARE:

- Direct Reading Velocity
- Discharge Measurement & Storage
- RRDL3 - Storage Set Up, Download and Store 10 Logger Memories.
- Tipping Bucket Raingauge Calibration.
- Surveying
- Custom Packages

HARDWARE

- Touch Screen Control
- Replaces Laptop Computers In The Field
- RS-232 Interface
- Pelikan™ Case Housing
- High Temperature LCD Touch Screen -20 to +70°C
- Rechargeable Batteries

ISO 9001
QUALITY SYSTEM CERTIFIED

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HYDROLOGICAL INSTRUMENTS & EQUIPMENTS
DESIGNED AND MANUFACTURED
BY HYDROLOGISTS

DESCRIPTION:

The Hydrological Services HydroMate, is one of our latest innovations, it can be described as hydrographer's best field companion, eliminates the use of costly and high power consumption Portable Computers.

The HydroMate is made for use with Current Meters, RRDL3 data loggers, Tipping Bucket Raingauge's. All HydroMate functions are touch screen selectable. These functions include setting up parameters, data input and download and data store from loggers. The stored data can be then downloaded into your system database.

The HydroMate is a state of the art microprocessor based instrument used to measure the discharge of water when used in conjunction with Current Meter Fans. The HydroMate operates as an autonomous unit allowing fan calibration formulas to be entered so that direct reading of river flow can be accurately measured without further reference to the calibration date supplied with the fans.

Additionally it can be used for the field calibration of Tipping Bucket raingauge, and collecting and storing survey information.

Custom software can be developed for your special requirements.

SPECIFICATIONS:

HydroMate with re chargeable batteries and inbuilt battery charging circuit, high temperature LCD touch screen control, storage capacity for 10 to 15 data loggers of data, plus 10 discharge measurement RS-232 communications port, with software to set up and download data from our RRDL3 series data loggers.

Microprocessor	Rabbit 2000
Program Memory 4 Mbit Flash	
Data Memory	On Board 8 Mbit Serial EEPROM Optional External Plug in Data Card
Data Buffer	4 Mbit RAM
Communications	RS232 port configured as DCE
Power supply	2 "D" cell rechargeable Ni-Mh can be replaced by alkaline cells in an emergency
Re charging	In built recharging circuit. Mains or Vehicle charging
Display	240 x 128 dot matrix STN LCD. Backlight, touch screen.
Temperature	-20 To 70°C
Humidity	0 To 100%
Ingress Protection	IP65
Housing	Pelican™ waterproof case
Size	210 x 175 x 90 mm
Weight	1.6 Kgs
Packed Details	0.01m³, 2.5 Kg

Specifications are subject to at anytime without notice.

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Annex 4

Tentative instrument budget

Tentative Instrument Budget

Water level stations

5 pcs. complete stations w/pressure transducers	NOK 59,000.00
1 pc Hydro Mate Field computer	NOK 9,000.00
1 pc Water level recorder w/chart	NOK 15,000.00
Stilling wells, construction materials, etc.	NOK 100,000.00
1 pc complete current meter w/ Hydro Mate Field computer and discharge logger	NOK 29,500.00

Rain gauges

50 pcs. SRG Standard Rain Gauge	NOK 68,000.00
2 pcs. TB4 Tipping Bucket Rain Gauge w/RRDL3-AN-LCD datalogger	NOK 30,000.00 (?)

TOTAL BUDGET (ex factory Sydney, Australia) NOK 310,000.00

References:

1) World Meteorological Organization, 2003: BASIC DOCUMENTS, No. 1

2) Assessment of Water Availability and Water Demand in Timor-Leste at River Basin Level, ADB TA: TIM 3986- Timor-Leste Integrated Water Resource Management, 6 August 2004.

3) Iralalaru, Laclo and Baucau Hydropower Projects, Timor-Leste. Iralalaru HPP – Draft Feasibilty Report.

4) Guidelines for a hydrometeorological network for Timor-Leste. ADB TA:TIM 3986, Integrated Water Resources Management, April 2004.

5) DRAFT NATIONAL WATER RESOURCES POLICY, ADB TA: 3986TIM Integrated Water Resources Management Project, July 2004.

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