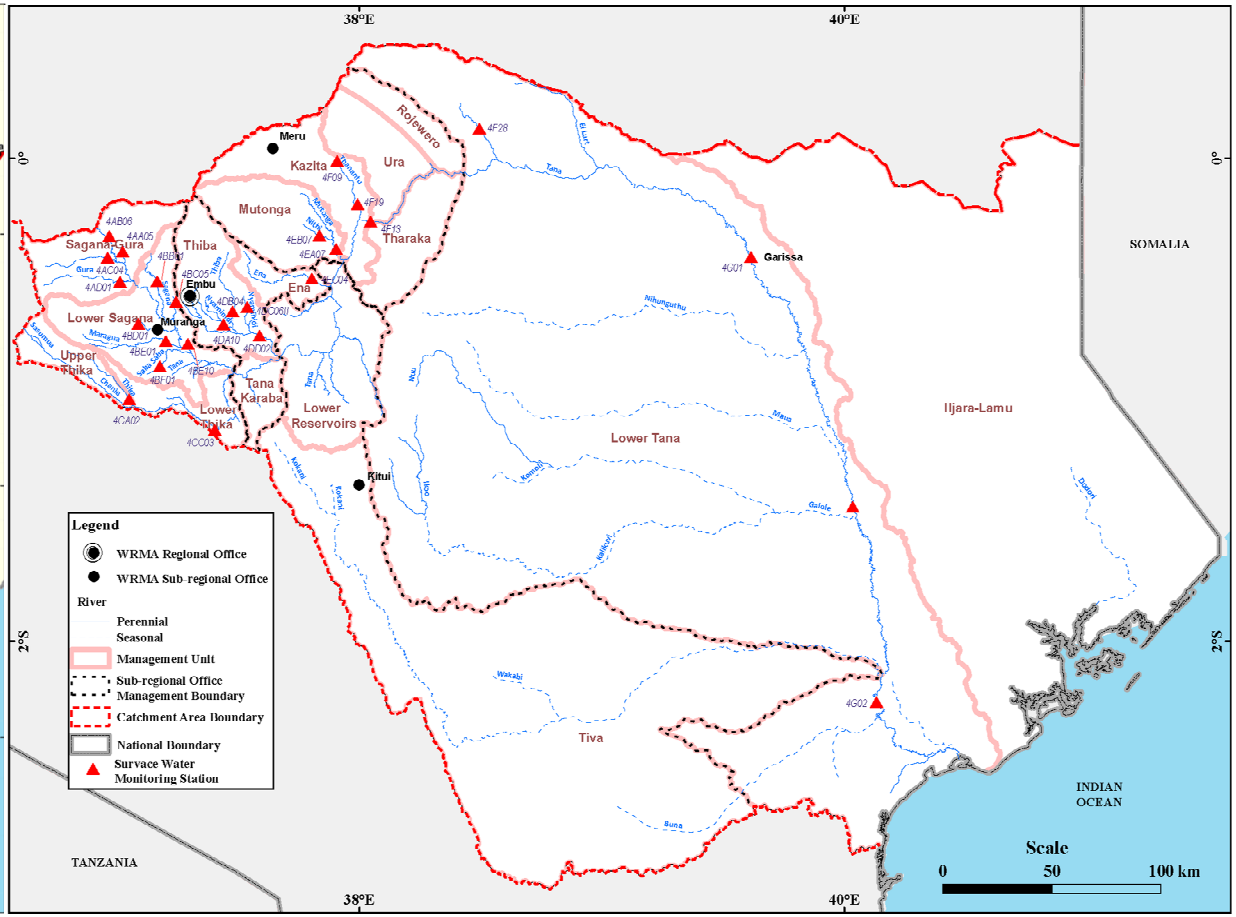
添付資料６

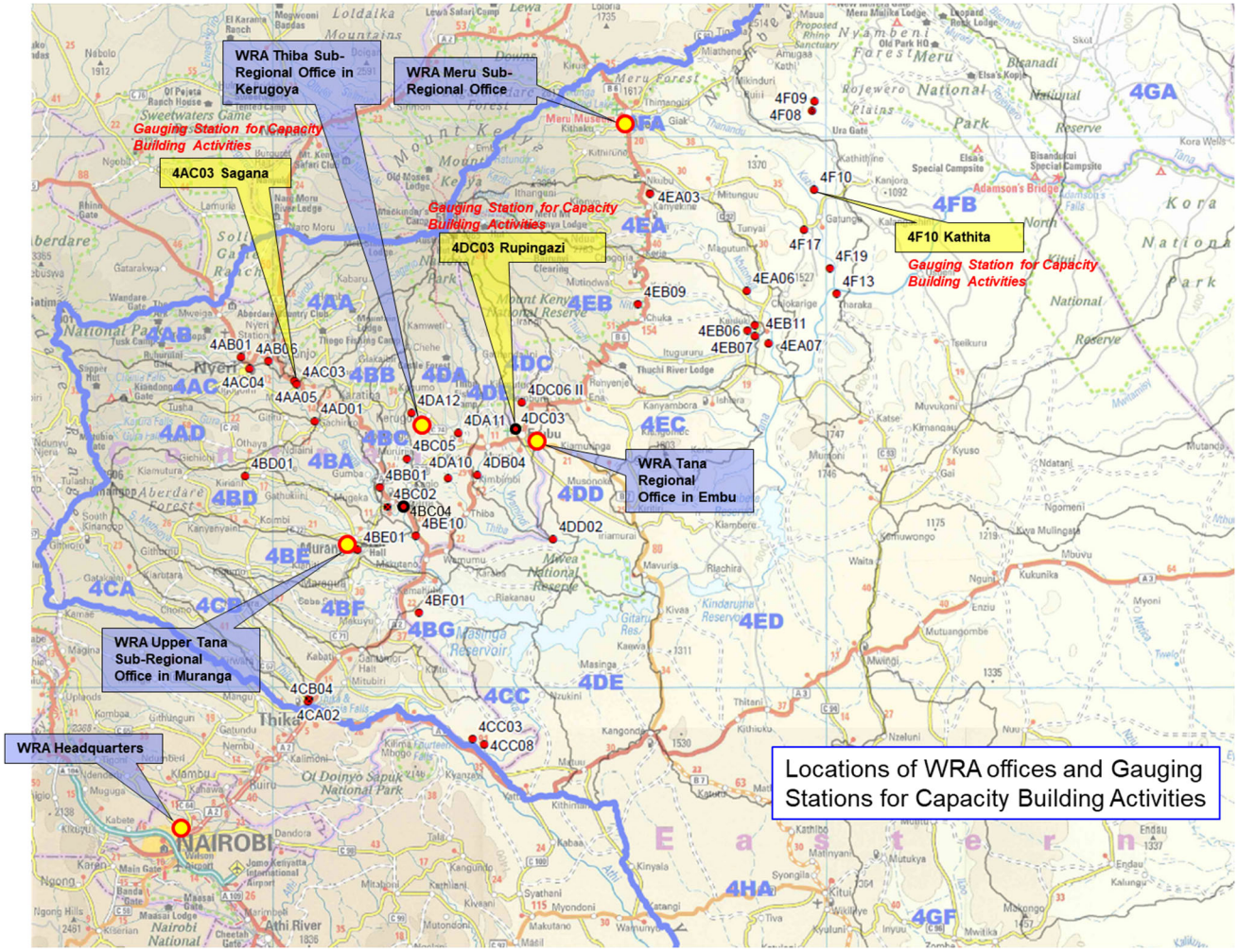
現地公開セミナー開催報告

Major River Basins in Kenya



Proposed Surface Water Monitoring Stations in Tana River Basin in the National WaterMaster Plan 2030

Seminars Report in Embu on September 17, 2024 and in Nairobi on September 19, 2024



Location Map of Activities

(Activity 4.5)

Discussion and notification to related organizations on the hydrological and meteorological data

Two seminars were held both in Emb and Nairobi in September 2024. Detailed contents of the seminars and their outputs are as described below.

(1) Seminar in Embu

The seminar in Embu was held on September 17, 2024 (Tuesday) at Izaak Walton Hotel in Embu. The seminar was attended by **24** participants from related stakeholders, WRA and JICA including JICA Experts Team. In the morning session, remarks by WRA and JICA were made and an introduction of WRA activities both in headquarters and Tana Basin Office were presented. After that the outlines and major activities of JICA Experts Team were presented. In the afternoon session, introduction of each expert activity was presented for Hydrological Monitoring, Telemetering and Innovation Technologies,

Flood Early Warning System (FEWS) and River Runoff Inundation (RRI) Model introduction.

Table 2.1.1 Seminar Outlines in Embu

SEMINAR IN EMBU	
Venue/Date	**Embu- Izaak Walton Hotel September 17th 2024**
purpose	Dissemination of information sharing methods to assumed users of monitoring data and analysis
Invited Participants	1) WRA: Water Resources Authority 2) JICA: Japan International Cooperation Agency including JICA Experts Team 3) Kenya Meteorological Department (County Directors) 4) County Governments – (Kirinyaga, Meru, Embu, Muranga, Tharaka-Nithi, Kitui, Garissa) 5) Blue Deal Program 6) WRA Region and Sub Region (Embu, Kerugoya, Meru, Muranga, Kitui, Garissa) 7) Kenya Red-cross Regional Office 8) Delmonte 9) NIA: National Irrigation Authority Regional office 10) WRUA (2 Representatives) 11) County Commissioner

Table 2.2.2 Seminar Program in Embu

Time	Activity	Speaker/Facilitator	Venue
08:30 - 09:00	Registration	WRA/JICA Expert Team	Hotel Lobby
09:00 - 09:15	Opening Remarks and Introductions	WRA - Chief Executive Officer (CEO)	Main Hall
09:15 - 09:25	Opening Remarks	JICA Representative	Main Hall
09:25 - 09:45	Introduction of WRA's Work	WRA –Manager Water Resources Assessment and Monitoring (M-WRAM)	Main Hall
9:45 - 10:00	WRA's Work in Tana and JICA Expert WRA joint Activities	WRA – Tana Basin Area Coordinator	Main Hall
10:00- 1030	Introduction of JICA expert WRA Activities incl. Q&A	Team Leader of JICA Experts Team Mr. Okamura	Main Hall
10:30-11:15	Tea/Coffee Break		Lobby
11:15-12:00	Hydrological monitoring and Data Management incl. Q&A	JICA Experts Team Mr. Okada/ Dr. Masika	Main Hall
12:00 –12:45	Real time Telemetric Data Acquisition and applications -Tana Basin and New technology, including Q&A	JICA Experts Team Mr. Azuma/ Mr. Eugene	Main Hall
12:45 - 14:00	Lunch Break		Dining Area
14:00 - 14:30	Introduction of FEWS and RRI	JICA Experts Team Mr. Okada/ Dr. Masika	Main Hall
14:30 - 15:15	Interactive Session Q&A - Identifying Issues and Opportunities	WRA and Key Stakeholders	Main Hall
15:15 - 15:45	Tea/Coffee Break		Lobby
15:45 - 16:00	Closing Remarks and Way Forward	WRA, JICA Team	Main Hall

After the presentation reactions from participants were made and replies and discussions were made accordingly as "Interactive Session Q&A. The followings are the results of reactions, replies and discussions.

Results of Interactive Session Q&A in Embu Seminar

QE1: Discharge measurements was done at low or medium flow, yet the focus should be high flows.

Response: the project targeted to use wading method in discharge measurement hence only suitable for low and medium flows. A rating curve (H – Q equation) should be used with caution, especially on sites affected by scouring, deposition, shifting, and moving beds. The alternative is expensive river training for a stable H – Q curve. An ADCP is most suitable for accurate measurement of high flows.

QE2: Telemetric equipment Inspection and O&M should be decentralized, and budget allocated for the same, how about outsourcing service?

Response: It was noted that resource deficit is a concern in implementing effective equipment inspection, operation and maintenance. Outsourcing would not be orderly because the activity is part of the mandate of WRA which has trained staff to carry out the activity and has been affected by low budget allocation over time.

QE3: How do you deal with vandalism of WRA equipment and batteries?

- **Response:** Changing logger housing designs by fool proofing with tiny steel reinforced equipment housing and doors and use of concrete columns to on which equipment is fixed vertically. Team up with WRUAs, water abstractors and community i.e. Citizen science to address this menace. Additionally, also Kenya Civil Aviation Authority on specialized drone fees on surveillance costing.

QE4: How does WRA deal with scarcity amid competitive water use that causes conflict?

- **Response:** WRA recommends 90-day storage as one of the conditions when issuing water permit. Similarly, stakeholders are encouraged to store night flows for use during the day.

QE5: What area some of the best practices in Rainfall forecasting, flood & drought mitigation

- **Response:** In Kenya, Rainfall forecasting is the mandate of KMD. In Japan, institutions collaborate for rainfall forecasting, flood and drought management. Some services are outsourced from vendors. Similar stakeholder collaboration approach is also practiced in Japan for water rationing to address drought conditions and resource utilization negotiated supply to mitigate shortfall in allocations for permitted thresholds through *Ad hoc* Joint meetings.

QE6: Can JICA support training and establishing pilot study for FEWS and RRI operationalization, equipment, and machines?

- **Response:** WRA should **r**equest JICA for support in writing to JICA Kenya office. Mr. Okada will then be deployed to engage on the same as a new project, if the request is approved by the JICA Committee. Meanwhile WRA can kick start the use of GSMaP and RRI Software to continue developing information products for their advisory services on the 10No. flood-prone areas while awaiting JICA support.

QE7: Clarification on Met sharing raw data and its dissemination.

- **Response**: KMD shares rainfall MAM rainfall forecasts periodically and the forecast was very reliable in the recent forecasts. No loss of life due to dam spills in April 2024 floods were reported. KMD shares its data to the public on request in writing to the Director at its headquarters at a nominal fee per parameter.

Comment: The Project is coming to an end yet not all activities envisaged at commencement are covered. There is need to countercheck agreed activities against output. In reporting the results, the project should develop a matrix of activities versus achievements realized.

QE8: Is the 90 Day Storage for In-stream or Off-stream?

Response: Policy for 100 Dam permitting has to also address catchment management (for base flow stabilization). Permits are issued with WRUAs approval and recommendations in hydrological reports prepared by a Professional hydrologist.

(2) Seminar in Nairobi

The seminar in Nairobi was held on September 19, 2024 (Thursday) at Fairview Hotel in Nairobi. The seminar was attended by **32** participants from related stakeholders, WRA and JICA including JICA Experts Team. The proceedings were the same as that of the seminar in Embu. In the morning session, remarks by WRA and JICA were made and an introduction of WRA activities both in headquarters and Tana Basin Office were presented. After that the outlines and major activities of JICA Experts Team were presented. In the afternoon session, introduction of each expert activity was presented for Hydrological Monitoring, Telemetering and Innovation Technologies, Flood Early Warning System (FEWS) and River Runoff Inundation (RRI) Model introduction.

Table 2.3.3 Seminar Outlines in Nairobi

SEMINAR IN NAIROBI	
Venue/Date	Nairobi - Fairview Hotel September 19th 2024
purpose	Dissemination of information sharing methods to assumed users of monitoring data and analysis
Participants	1) MWSI-Ministry of Water, Sanitation & Irrigation: Water, Irrigation Secretary 2) WRA: Water Resources Authority 3) JICA: Japan International Cooperation Agency including JICA Experts Team 4) KMD: Kenya Meteorological Department 5) NIA: National Irrigation Authority 6) HSK: Hydrological Society of Kenya 7) ACEK: Association of Consulting Engineers of Kenya 8) KSA: Kenya Space Agency 9) Blue Deal Program 10) Kenya Red Cross: Kenya Red Cross Society, Nairobi 11) NDMA: National Drought Management Authority 12) NDOC: National Disaster Operations Centre 13) KEWI: Kenya Water Institute 14) AWWDA: Athi Waterworks Development Agency 15) KenGen: Kenya Electricity Generating Company

Table 2.4.4 Seminar Program in Embu

Time	Activity	Speaker/Facilitator	Venue
08:30 - 09:00	Registration	JICA Experts Team/WRA	Hotel Lobby
09:00 - 09:15	Opening Remarks and Introductions	WRA - Chief Executive Officer (CEO)	Main Hall
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15:45 - 16:00	Closing Remarks and Way Forward	WRA, JICA Experts Team	Main Hall

After the presentation reactions from participants were made and replies and discussions were made accordingly as “Interactive Session Q&A. The followings are the results of reactions, replies and discussions.

Results of Interactive Session Q&A in Nairobi Seminar

QN1: How can the WRUAs and IWUAs work harmoniously?

- **Response:** A WRUA operates at sub-basin level that includes different water users. IWUAs should be sought to be incorporated in the membership of the WRUA as recognized by law. WRUAs advice is sought during water use permitting process.

QN2: How can we ensure that the data obtained by WRA reach major schemes on time? Do we have a direct relationship between WRA and NIA in flood monitoring?

- **Response**: WRA readily shares its data after an official request at a cost. WRA has several products that NIA could benefit from including the flood advisories issued regularly through various channels such as local radios, its website, and social media.

QN3: How much does it cost for the groundwater monitoring kits used to monitor water use? Is it cost-effective for

individual farmers? How can WRA ensure farmers monitor groundwater levels? Sediment deposition ruins pump propellers due to catchment degradation.

- **Response**: People always revert to groundwater sources, especially during the dry seasons. WRA issues permits to all abstractors for monitoring water levels and aquifer characteristics. Groundwater use is monitored by WRA who have express authority to carry out the activity even in privately owned boreholes. For each borehole commissioned, WRA recommends installation of a water master meter to monitor abstraction. Specialized equipment like dippers is regularly used for onsite level determination. An individual farmer may use this data for personal auditing of water use. To deal with droughts, permit conditions require an abstractor to have 90-day storage for irrigation water use since direct abstraction from the river is not sustainable. Each project should have a catchment management component to address sediment generation.

Comment: WRA should consider replication of Nzoia FEWS in Tana owing to its success in flood mitigation.

- **Response**: WRA is in the process to do so along Mr. Okada approach as will be presented later

QN4: Why do you recommend the SEBA system?

- **Response**: Owing to experience gathered so far, SEBA equipment has been found to perform very well. It's a compact system and is maintenance free. The cost is reasonable for WRA compared with other systems installed so far. It fits the notion 'what is working is good and SEBA is working well'! WRA is however currently focusing on non-contact systems to measure water levels such as radar. Contact systems like transducers are open to vandalism and can be washed away by floods as is evident from the field reports.

QN5: How well is the uptake of telemetric technology by WRA? How long will it take to catch up with the data to be collected? What challenges are experienced in Japan?

- **Response:** WRA has 123 telemetric gauging stations in the country. Out of this, 65 stations monitor river water levels. Telemetric stations for monitoring groundwater and climate data are also in place. Plans are ongoing to also install more water quality monitoring stations too. The data from these stations can be accessed in real-time from the WRA's Water resources management Information system. The data is analyzed, packaged and information products used for water resources management. Japan challenges include hurricanes, cyclones, typhoons and other disasters such that Disaster Management and adaptation is of utmost concern and have put in control measures to reduce impacts of same. However, natural phenomena disasters are hard to fully control.

QN6: Was the precipitation data validated using the ground data?

- **Response:** The data was compared with rain gauge data from one station. Note that many of the rain gauges have daily data sets, unlike the GSMAP data which is hourly making it challenging for calibration. Further, KMD and WRA had installed telemetric and automatic rainfall gauge stations that will be useful in future for calibration since it has hourly data. Collaboration with KMD, NDOC and relevant stakeholders for synergy on GFS, EUMETSAT forecasts with GSMaP products based FEWS is necessary.

QN7: Is the GSMaP technology available for WRA?

- **Response**: The current product is a prototype developed to illustrate its potential use in the Tana basin. RRI and GSMaP rainfall are open-source products that can be accessed by all. The setup requires training and some WRA staff used their laptops last week to run it during a training session.

QN8: When the graphics are presented, to what extent does WRA engage with NEMA in the sense that all projects should use such information (derived from the RRI presentation) to give a good starting point for project evaluation?

- **Response**: NEMA and WRA collaborate very well. NEMA submits its reports that have an impact on water resources to WRA for evaluation. WRA approves some projects as well as rejects others based on sound data analysis. WRA does its part but sometimes the advisory is not considered in some development projects which raises serious gaps in collaboration.

QN9: Did you try to estimate the magnitude of April 2024 floods?

- **Response:** Only the rainfall data was considered for frequency analysis in the prototype. Discharge data was not analyzed for flood magnitude. However, the gauge at Garissa provided insights on water level variation, likely depth changes and inundation extent.

Photos

(1) Embu

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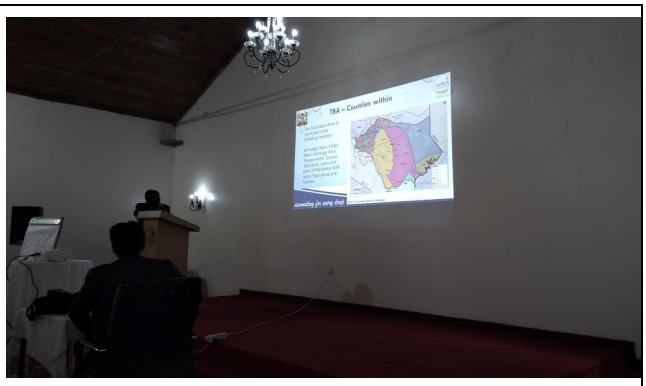
<tr><td>  </td><td>  </td></tr>
<tr><td>Remarks by WRA Hydrologist Mr. Ruben Ngessa</td><td>Presentation by WRA Tana Basin Manager Mr. Abdi Omar</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Presentation by Mr. Y. Azuma (Telemetering/Innovation Technology</td><td>A group photo of participants in Embu</td></tr>
</table>

(2) Nairobi

	
Opening remarks by Mr. S. Hamano, Senior Representative of JICA Kenya Office	Presentation by Mr. Y. Okada, Hydrologist of JICA Experts Team
	
Seminar participants in Nairobi	A group photo of participants in Nairobi

OVERVIEW OF WATER RESOURCES REGULATION AND MONITORING IN KENYA

SEMINAR ON ENHANCING INFORMATION SHARING FOR WATER RESOURCE MONITORING AND ANALYSIS

JICA- KENYA WATER RESOURCES ADVISORS PROJECT

17th September 2024

IZAAK WALTON HOTEL, EMBU - KENYA

Presenter: Reuben Ngessa

Contents

1. ROLE OF WRA IN THE WATER SECTOR

Water Resources Authority (WRA) established under **Section 6 of Water ACT 2016** serves as an agent of the National Government to regulate the management and use of water resources

Section 12: WRA Mandates

Regulation of Management & Use of Water Resources

Regulation

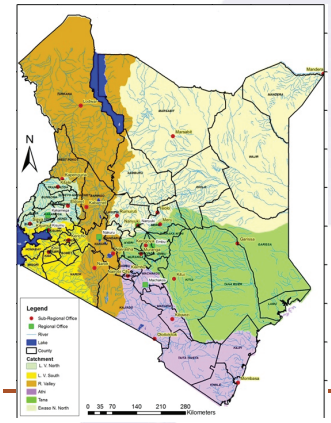
- Permits
  - Determine & set permit & water use fees
  - Issue, vary & enforce permit conditions
- Facilitate the development of procedures and regulations for management and use of water resources and flood mitigation

Management

- Enforce the Water Act 2016 and Regulations under the Act
- Issue authorisations for development of works including National Public Water Works
- Enter into agreements with Water Service Providers for protection of catchment areas amongst other water resource management and use measures
- Provide information and advice to the Cabinet Secretary for the formulation of national water resources management, water storage and flood control strategies
- Monitoring compliance by water users

Development of Water Resources

Water Services



Basin Management Approach

- ✓ Kenya is divided into five drainage basins namely;
  - ✓ ATHI - 58,639km^2
  - ✓ TANA- 126,026km^2
  - ✓ RIFT VALLEY - 130,452km^2
  - ✓ EWASO NGIRO NORTH - 210,223km^2 (25% of Kenya)
  - ✓ LAKE VICTORIA - 31,734km^2
- ✓ The Basins traverse a number of Counties
- ✓ WRA has 6 regional offices and 26 sub regional offices
- ✓ Catchment Management Tools: Basin Plans, Sub Basin Management Plans.
  - o WRA works with other stakeholders to implement the Catchment Management Tools in line with the **CoK and Water Act, 2016**

2. CHALLENGES IN WATER RESOURCES MANAGEMENT

Available Water Resources by basins (Units in MCM/yr.)

Catchment Area	Area (sq.km)	2010	2030	2050
LVNCA	18,374	4,742	5,077	5,595
LVSCA	31,734	4,976	5,937	7,195
RVCA	130,452	2,559	3,147	3,903
ACA	58,639	1,503	1,634	2,043
TCA	126,026	6,533	7,828	7,891
ENNCA	210,226	2,251	3,011	1,810
Total	**575,451**	**22,564**	**26,634**	**28,437**

Water Demand per Region *(Units in MCM/yr.)*

Catchment Area	Area (sq.km)	2010	2030	2050
LVNCA	18,374	228	1,337	1,573
LVSCA	31,734	385	2,953	3,251
RVCA	130,452	357	1,494	1,689
ACA	58,639	1,145	4,586	5,202
TCA	126,026	891	8,241	8,476
ENNCA	210,226	212	2,857	2,950
Total	**575,451**	**3,218**	**21,468**	**23,141**

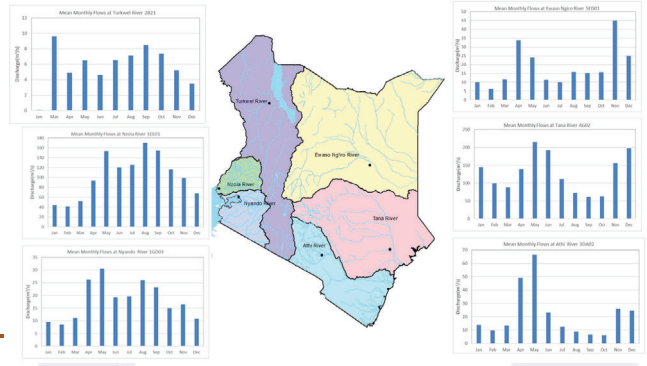
With an estimated population of 50 million, Kenya faces enormous challenges in the management of its limited water resources.

The challenges include:

- water scarcity and variability (in space and time)
- water pollution (point and non-point)
- catchment degradation (Encroachment of water sources)
- Impacts of climate change (Severe floods and Droughts)

The magnitude of the challenges and the severity of the water crisis facing Kenya cut across most sectors of the economy; hence, making water resources management a high priority

Flow Variability



MANUAL TO TELEMETRY EQUIPMENT

WATER RESOURCES DATA COLLECTION, QC & ANALYSIS

3. WATER RESOURCE ALLOCATION

- The water resources are *finite and valuable*, implying priority on beneficial use and that restrictions are required;
- The **basic principles** are grounded in concepts of **equity, reliability, socio-economic development,** and **environmental conservation.**
- Water resources are allocated with CONDITIONS that relate to availability of the resource . The conditions can be different depending on the intended use or user.

4. WATER RESOURCES MONITORING

Surface Water Monitoring Stations

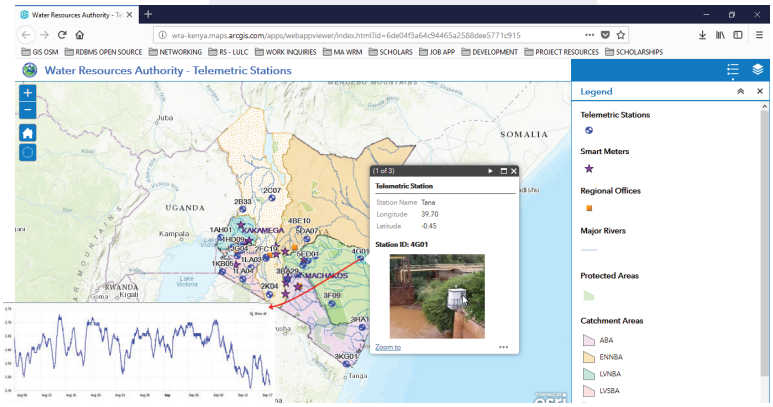
Region	Category			Total
	National	MU	IMU	Special	
LVWBA	5	6	10	7	**28**
LVSBA	5	14	26	2	**47**
RVBA	4	8	14	0	**26**
ABA	3	4	21	3	**31**
TBA	1	24	15	15	**52**
ENNBA	1	5	33	1	**40**
Total	**22**	**48**	**122**	**31**	**223**

118 automated with data loggers and Telemetry System
- 65 water level
- 53 climatic

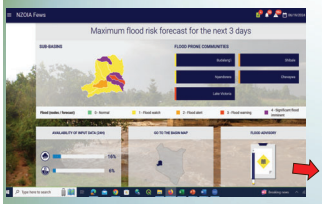
WRA also monitors **Ground Water** (142 stns rationalized) and **Water Quality** (658 stns rationalized)

Water Demand

Water Resource Information System

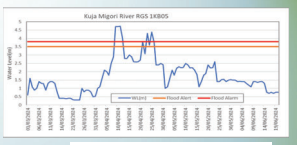


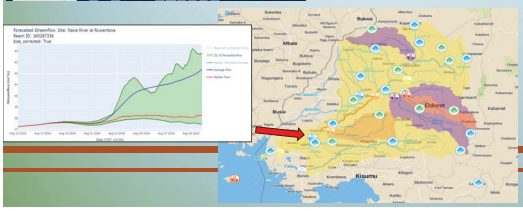
NZOIA FLOOD EARLY WARNING SYSTEM



NZOIA-BULLETIN.PDF

FLOOD ADVISORIES





WATER RESOURCES AUTHORITY
TANA BASIN AREA

JICA SEMINAR

IZAK WALTON HOTEL - EMBU

17/09/2024

ABDI OMAR – BASIN AREA COORDINATOR

WRA is ISO 9001:2015 Certified

accounting for every drop

Report Corruption/Water Resources Destruction anywhere in Kenya! 24 Hour Emergency Line: 0700 056472

About WRA

- A State corporation established under Section 11 of the Water Act, 2016.
- it safeguards the right to clean water by ensuring that there is proper regulation of the management and use of water resources on behalf of the National Government

✓ ***To ensure sufficient water for everyone- now and in the future***

- WRA operates (6) Basin Area offices across the country.
- These offices cover the 5 major Water Towers
- ✓ ***(Mt. Kenya, Mt. Elgon, Mau Complex, Aberdares and Cherangani Hills)***
- There are 26) Sub-Basin Areas spread across the country.

WRA is ISO 9001:2015 Certified

accounting for every drop

Report Corruption/Water Resources Destruction anywhere in Kenya! 24 Hour Emergency Line: 0700 056472

WRA Functions & Roles

PROTECTION

Water Resources Authority also controls pollution and improves water quality in the country's water bodies. This involves intergrating land use activities into WRA Water Quality Control programs.

REGULATION

Vater Resources Authority (WRA) sustainably and equitably allocates water resources among the arious competing needs. WRA also requires that akeholders are involved in the process. The "Water use Permit" is used to carry out this function.

CLIMATE CHANGE ADAPTATION

The Authority undertakes climate actions in terms of mitigation and adaptation to minimizing the effects of global warming and climate change.

DISSEMINATION

The Authority collects all information on water resources, analyses, stores and disseminates it. This information is critical for water allocation, water resources investment decision making and modeling to enact scenarios to better understand the impact of climate change in future.

WRA is ISO 9001:2015 Certified

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WRA Functions & Roles as provided under section 12 and 13 of the Water Act 2016; These are as follows:

1. Formulate standards, procedures and regulations aimed at ensuring proper management and use of water resources.
2. Enforce Regulations formulated by WRA so as to ensure compliance through inspection, monitoring and enforcement.
3. Receive water permit applications for water abstraction, water use and recharge and determine, issue, vary water permits; and enforce the conditions of those permits
4. Regulate Water use allocation
5. Collect water permit fees and water use charges
6. Provide information and advice the Cabinet Secretary for formulation of policy on National Water Resource Management, water storage and flood control strategies
7. Coordinate with other regional, national and international bodies for the better regulation of the management and use of resources
8. Manage the National Monitoring and Information System

accounting for every drop

Report Corruption/Water Resources Destruction anywhere in Kenya! 24 Hour Emergency Line: 0700 056472

What we do;

- ❖ As a Regulator, our approach in safeguarding the resource entrenched in the Water Act 2016, Country's development agenda, Vision 2030 strategic objective on water and sanitation and the SDG 6.
- ❖ WRA aim to increase water resources availability for multipurpose use but also improve the quality and sustainability of water resources.

accounting for every drop

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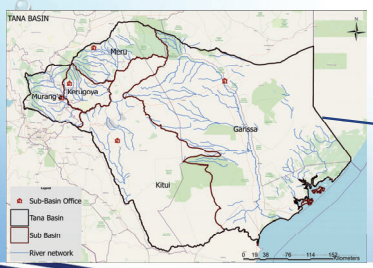
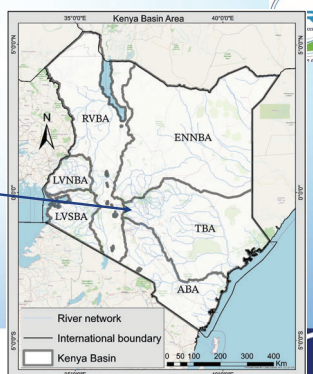
WRA :Basin Areas





accounting for every drop

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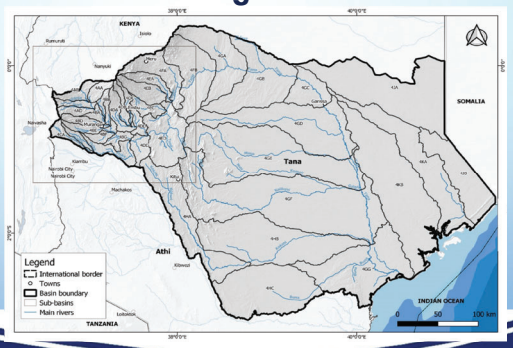
WRA – Tana Basin Area

Theme	Attributes
Area	126,026 km² (about 21% of the area of Kenya)
Population - 2019	6.96 million (~14.9% of the total population of Kenya.
Urban Population	1.53 million
Rural Population	5.43 million
Population Density	55 persons/km²
Nairobi	80% of the water consumed in Nairobi originates from Upper Tana
Rivers/tributaries	Chania, Thika, Thiba, Ena, Thuci, Amboni, Gura, Ragati, Mathioya, Kathita, Mutonga, Sabasaba, Maragwa, Ura-Rujiweru, Tana, Sagana and Thangatha

WRA is ISO 9001:2015 Certified

TBA – Drainage network



TBA – Counties within

The Tana Basin Area is domiciled in the following counties:

Kirinyaga, Nyeri, Embu, Meru, Muranga, Kitui, Tharaka-Nithi, Garissa, Tana River, Lamu and parts of Machakos, Kilifi, Isiolo, Nyandarua and Kiambu

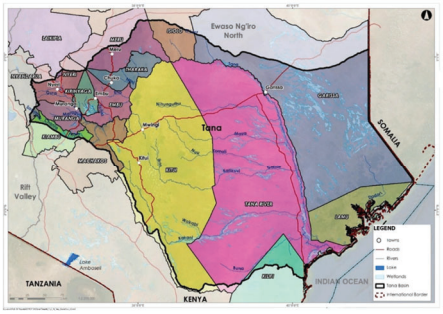
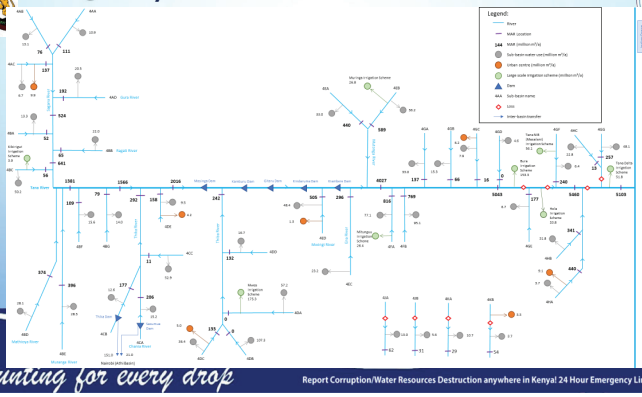


Figure 2-2: Counties within the Tana Basin

Modern day water use in Tana Basin



What we do; County & Community engagemnet

Role; Engages Water Resource Users Association (WRUA) & Counties in implementing integrated water resource activities.

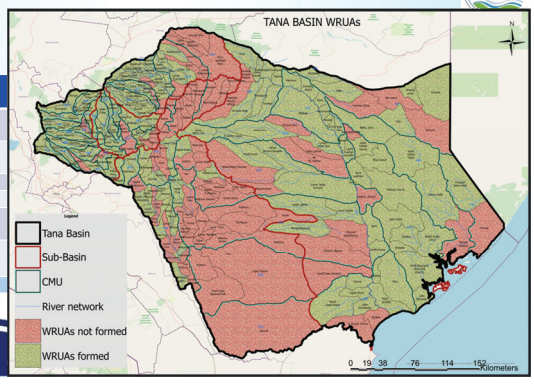
- The Division is charged with the responsibility of translating water resources science to communities to implement water resources activities, climate change, flood management and livelihood for sustainability
- WRUA formation, Sub-Catchment Management Plans (SCMP) development and implementation

WRA is ISO 9001:2015 Certified

Cont..County & Community engagemnet

WRUA formation

No.	SBA	Formation	SCMPS
1	Upper Tana	34	33
2	Kathita Mutonga	30	30
3	Thiba	21	17
4	Tiva Tyaa	28	20
5	Lower Tana	81	34
	Totals	194	134



Cont…; County & Community engagemnet

SCMP Implementation

- SPRINGS PROTECTION AND DEVELOPMENT
- CONSERVATION AND STABILIZATION OF RIVER BANKS AND DEGRADED CATCHMENT SITES -TREE SEEDLINGS PLANTING
- CONSTRUCTION AND REHABILITATION OF WATER STORAGE INFRASTRUCTURE- PANS, SAND DAMS
- CONSTRUCTION OF COMMON INTAKES
- LIVELIHOOD ACTIVITIES –GREENHOUSES, TREE NURSERY, FISH FARMING , BEEKEEPING

Cont…; County & Community engagemnet

- SPRINGS PROTECTION AND DEVELOPMENT

SCMP Implementation

- SPRING PROTECTED BY LOWER RUPINGAZI WRUA

Cont…; County & Community engagemnet

SCMP Implementation

- LIVELIHOOD ACTIVITIES –GREENHOUSES, TREE NURSERY, FISH FARMING , BEEKEEPING

▪Fish Farming in Muringato and South Mathioya WRUAS

Cont…; County & Community engagemnet

SCMP Implementation

▪Construction and Rehabilitation of water storage infrastructure- Pans, sand dams

RAINWATER HARVESTING AND STORAGE TANK INSTALLED AT UPPER ENZIU WRUA, KITUI SUB REGION

Kamudhe Sand dam constructed by Madogo WRUA , Garissa

Tana Key Stakeholders & Partners

❑JICA

- **RIVER DISCHARGE MEASUREMENTS &CROSS SECTION SURVEYS**

➢4AC03, SAGANA

➢4BB01, RAGATI

➢4BC02, TANA SAGANA

➢4BE01, MARAGUA

➢RGS 4F13, TANA RIVER GRAND FALLS,

➢4EC3 ENA RIVER

Tana Key Partners

JICA

- **Blue Deal Project**
- **Upper Tana Nairobi Water Fund Trust**
- **BornFree**
- **USAID STAWI**
- **IUCN –International Conservation of Nature**
- **Nature Kenya**
- **WWF**
- **The County Governments**
- **Among others**

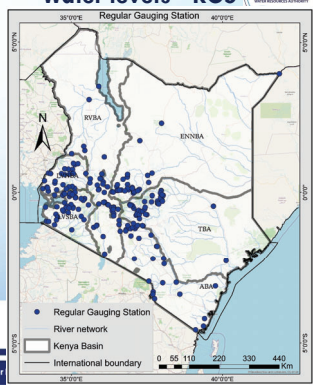
- **Capacity Building by JICA Expert Team**

What we do; Water Resources Assessment & Monitoring

Water levels - RGS

Role: Collects, stores and analyses and disseminates hydrological and meteorological data to facilitate equitable water resource allocation, design of water resource infrastructures, early warning on floods and droughts and water resources decision support

Sub-Regional Office	Total Number of surface water Stations			
	Telemetric	Automatic	Manual	TOTAL
Garissa	3	2	0	5
Kerugoya	8	1	10	14
Kitui	0	0	0	0
Meru	6	8	14	25
Murang'a	13	15	11	28
TOTAL	30	26	35	91



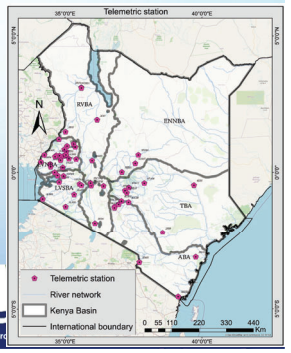
accounting for every drop

Report Corruption/Water

What we do; Water Resources Assessment & Monitoring

- WRA uses MIKE IPO System for hydro-meteorological data management.
- Allows access to temporal and spatial data sets for a variety of purposes.
- It's a Data collection and processing platform that ensures that reliable on-line data are available, for instance, to serve flood forecasting systems.

Telemetric stations



accounting for every drop

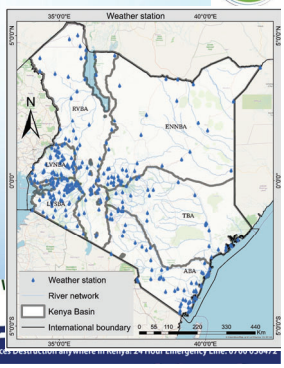
Report Corruption/Water Resour

What we do; Water Resources Assessment & Monitoring

- Includes Rainfall & Evaporation stations

	Rainfall	No. Operational	Evaporation	No. Operational	Climate	No. Operational	Total
ACA	45	27	8	3	2	2	32
ENNCA	26	12	4	0	9	6	18
LVNCA	72	30	10	3	5	0	
LVSCA	47	36	20	2	12	1	39
RVCA	24	23	7	6	3	2	31
TCA	52	31	14	11	2	0	42
Total	266	159	63	25	33	11	162

Weather stations



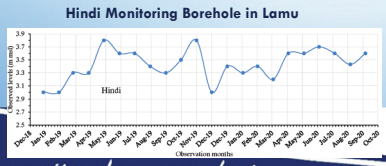
accounting for every drop

Report Corruption/Water Resources

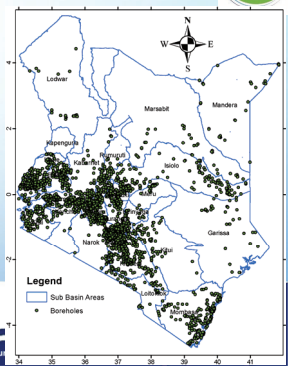
What we do; GroundWater Resources Assessment & Monitoring

	Strategic	Major	Minor	Special	Total	% Operational
Athi	44	12	4		60	53.3
ENNCA		16			16	75
LVN		20			20	90
LVS		14			14	64.3
RVCA	27	20			47	85.1
Tana		21	14	5	40	85.7
Total	71	103	4		178	75.6

Hindi Monitoring Borehole in Lamu



Spatial location of Boreholes



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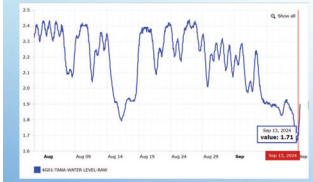
Report Corruption/Water Resou

What we do; Water Resources Assessment & Monitoring

Types of data



Data type	Description
Hydro-meteorological data	Surface Water (Daily water levels, River flows) Meteorological (Rainfall, Evaporation) Ground Water (Boreholes, Springs) Water Quality (Effluent, Surface water, Ground water)
Permitting	Abstraction points & Volumes Water Allocation Billing for water use Applications from Water users
Boreholes	Borehole Completion Records – Depth, Water strike levels, yield, quality, Borehole construction details, Test pumping reports
Reports	Water situation, Performance, Baseline, Water Allocation Water Resources Users Association (WRUA), Water Quality, Waste Disposal Control Plans (WDCP), Flood situation, Dams, Pans and weirs safety plans and Reports.

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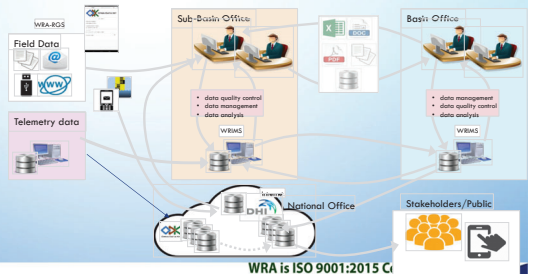
What we do; Water Resources Assessment & Monitoring

Data collection

- Water Resources Information System is a comprehensive and flexible data management and data integration system, focused on making temporal and spatial data sets available for a variety of purposes.
- Data collected in collaboration with WRUAs



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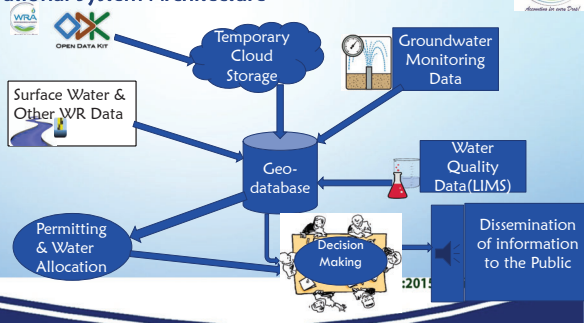
Report Corruption/Water Resources Destruction anywhere in Kenya! 24 Hour Emergency Line: 0700 056472

What we do; Water Resources Assessment & Monitoring

WRA Operational System Architecture

Data dissemination;



What we do; Water Resources Laboratory Services

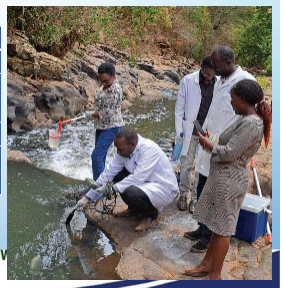
Role: Laboratory analysis of

i) Surface and ground water for domestic, irrigation, construction, research
ii) Wastewater (Effluent) to ensure that it is within the regulatory requirement.

- The laboratories can handle more than 40 different tests on a variety of water samples.
- WRA operates ten (10) labs across the country: In Tana we have laboratories in the Embu regional Office and Muranga which are well equipped and can perform various analysis

Services offered

Full Chemical Analysis
Partial Wastewater Analysis
Bacteriological analysis
Chemicals for water supply treatment works



What we do; Water Quality & Pollution Control

WRA Conducts water quality and pollution monitoring, surveillances and enforcement of Waste Discharge Control Plans (WDCPs) in the cases of point sources of pollution;
Facilities normally targeted are : water companies, manufacturing companies , institutions etc.

WRA also promotes waste recycling and reuse.
For the situations of non – point sources of pollution, integrated interventions are employed for enhanced catchment protection and conservation efforts that including;

- Solid and Liquid waste management.
- Riparian land protection and conservation
- Enhancing vegetative cover and silt trap
- Modern farming practices minimizing application of persistent organic pollutants.

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Management of the water resources information

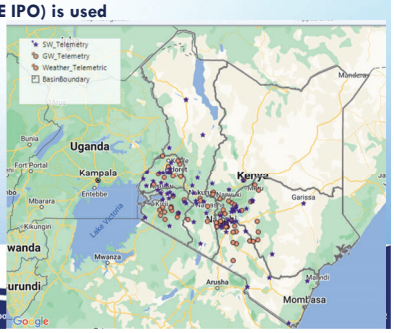
Surface water & Ground water Quantity and Quality

- Monitoring is done on Near real time basis
- Water Resources Information System (MIKE IPO) is used

Main features of MIKE INFO include:

- the storing of GIS datasets
- the storing of time-series data
- reporting capabilities
- publication and data sharing

Accessed via:
http://41.79.11.230:85/
http://172.16.0.82:85/



What we do; Permitting

Role; Regulating water abstractions for different uses while ensuring equitable sharing

- The process involves submitting an application.
- Issuing an authorization to construct abstraction works followed by
- Issuance of a water permit to the Owner of the Water Resources works Pursuant to Sec. 5 of the Water Act 2016

(every water resource is vested in and held by the National Government in trust for the people of Kenya, subject to any rights of the user granted by or under the Act).

- *For mode details; https://wra.go.ke/water-use-allocation/*

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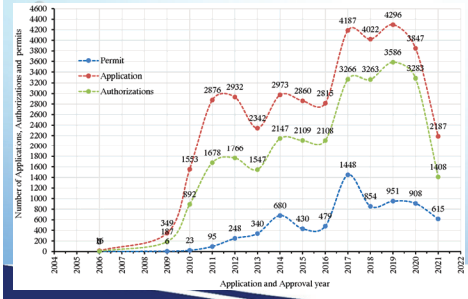
Key Achievements; Permitting

Example: Groundwater applications



E-permit system

- *How to apply*
- *Log in to e-citizen*
- *State corporations*
- *Check Water Resources Authority*
- *Select the service of your choice*

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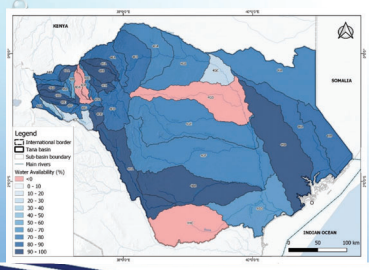
What we do; Permitting

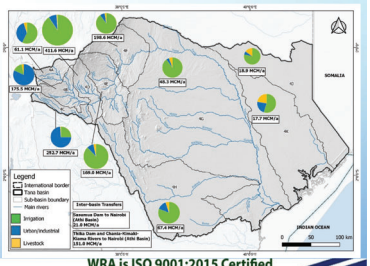
Permitting – Water availability and demand

Catchment Area	Area (sq.km)	2010	2030	2050
LVNCA	18,374	228	1,337	1,573
LVSCA	31,734	385	2,953	3,251
RVCA	130,452	357	1,494	1,689
ACA	58,639	1,145	4,586	5,202
TCA	126,026	891	8,241	8,476
ENNCA	210,226	212	2,857	2,950
Total	575,451	3,218	21,468	23,141

What we do; Permitting

Permitting – Water availability and demand





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What we do; Water Resources Assessment & Monitoring

Data requisition;

- Write an email requesting for the data info@wra.go.ke
- *Visit the respective office*
- *Via e-citizen*

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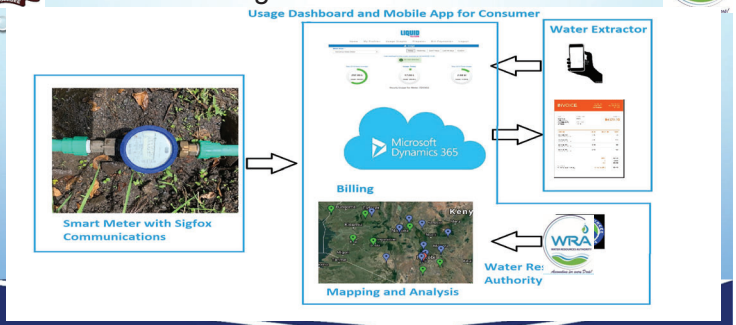
Smart Metering Solution for Water Abstractors

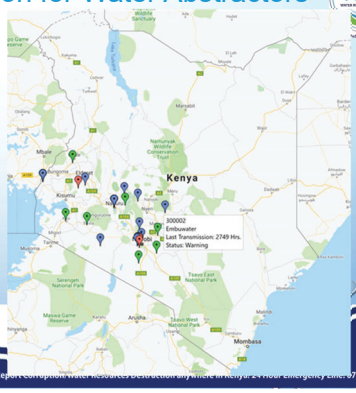
Water Metering



Smart Metering Solution for Water Abstractors

Water Metering

Abstractor's Name	Region	Point of Installation
Runda Water	ACA	River
Machakos water	ACA	Treatment works
Beacon of hope	ACA	Borehole
Del Monte	ACA	River
Gatundu Water	ACA	River
Kibwezi Water	ACA	River
Embu Water	TCA	Treatment works
Murang'a Water	TCA	Dam
Moi University	LVNCA	Treatment works
Nandi Kapsabet Water	LVNCA	Dam
Western Seed	LVNCA	River
Oloosuyian girls	RVCA	Borehole
JM Kariuki Hospital	RVCA	Borehole
GK Prisons Nyahururu	ENNCA	Borehole
Mini Bakeries Kisii	ENNCA	Borehole



Challenges

- Water use conflicts especially –ragati and thiba sub catchment
- Water scarcity
- Increased water resource demand, urbanization and industrialization
- Pollution of water resources from both point and non-pollution sources point
- Flooding and drought occurrences
- Catchment degradation-human encroachment on fragile ecosystems, loss of wetlands, riparian areas and sand harvesting
- Climate change impacts causing frequent prolonged droughts and floods
- Groundwater salinity in parts of lower tana & coastal zone
- Vandalism of
- Inadequate enforcement
- Encroachment

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Opportunities

- Involvement of development Partners &Stakeholders within Tana Basin Area.
- Grassroot involvement of WRUAs.
- Established Infrastructure for coordination.
- Synergy with other Agencies
- High experienced Technical staff
- Early warning systems

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Water Resources Authority (WRA)

Kenya Water Resources Advisor

Introduction of
JICA Experts Team Activities

September 17, 2024

1. Goal of activities

Strengthening of WRA's Capacity on Hydrological Data Management (Observation, Arrangement, Storage, Analysis, and Utilization)

2. Expected Outputs

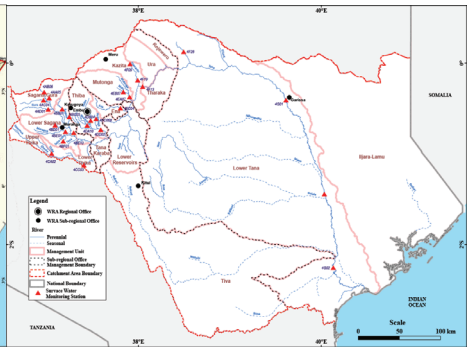
- **Output 1**
  Hydrological Monitoring Network Update in accordance with the Purpose of Observation
- **Output 2**
  Capacity Building on Hydrological **Monitoring**
- **Output 3**
  Capacity Building on **Arrangement and Storage** of Hydrological and Meteorological Data
- **Output 4**
  Capacity Building on **Analysis and Utilization** of Hydrological and Meteorological Data

3. Target Areas of Activities (1/2)

- Major Activities at WRA headquarters
- Practical Site Activities at Tana Catchment Area
- It is reported that the safety condition is not preferable in Garissa and further downstream areas. Activities in Tana Catchment Area such as training sessions will be held in Embu by calling related WRA staff.

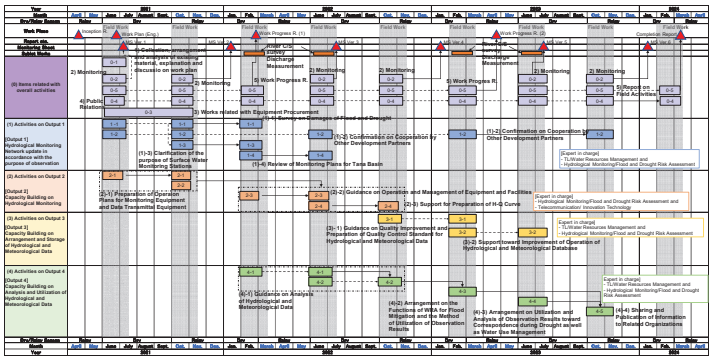
3. Target Areas of Activities (2/2)

Catchment Areas in Kenya



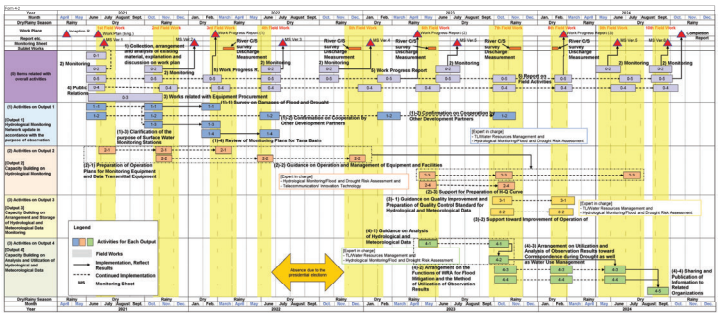
Hydrological Monitoring Stations in Tana Catchment Area (Proposed in the National Water Master Plan 2030)

4. Activities Flow Chart **Original Schedule**



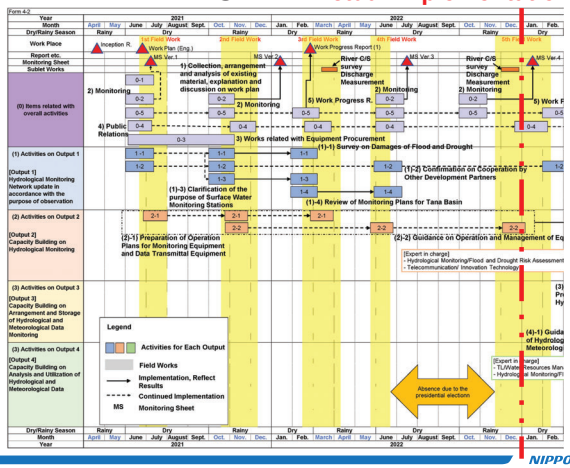
From April 2021 to April 2024

4. Activities Flow Chart **Actual Implementation**



Whole Period: From April 2021 to October 2024

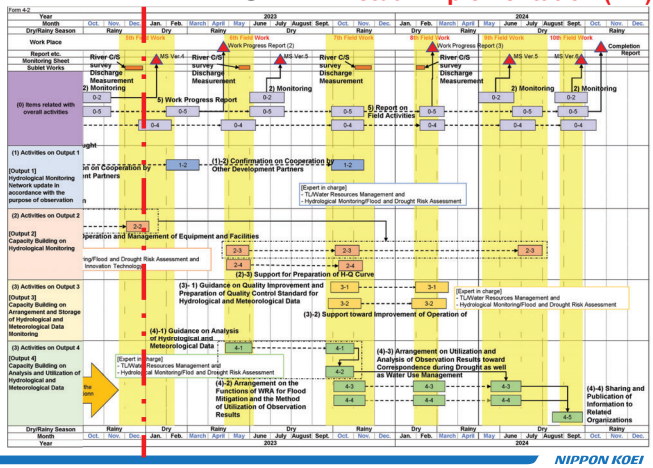
4. Activities Flow Chart **Actual Implementation (1/2)**



Period: From April 2021 to December 2022

NIPPON KOEI

4. Activities Flow Chart **Actual Implementation (2/2)**



Period: From January 2023 to October 2024

NIPPON KOEI

5. Assignment Schedule **Original Schedule**

Assignment Schedule

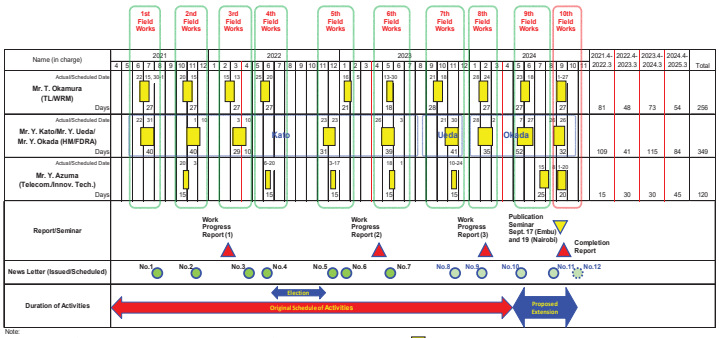
Name (in charge)	2021												2022												2023												2024			
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
Mr. T. Okamura (TL/WRM)																																								
Mr. Y. Kato (HM/FDRA)																																								
Mr. Y. Azuma (Telecom./Innov. Tech.)																																								

Note:
TL/WRM: Team Leader/ Water Resources Management, **HM/FDRE**: Hydrological Monitoring/ Flood and Drought Risk Assessment
Telecom./Innov. Tech.: Telecommunication/ Innovation Technology

NIPPON KOEI

5. Assignment Schedule **Actual Implementation**

Assignment Schedule (As of September 17, 2024)



Note:
TL/WRM: Team Leader/ Water Resources Management, **HM/FDRA**: Hydrological Monitoring/ Flood and Drought Risk Assessment
Telecom./Innov. Tech.: Telecommunication/ Innovation Technology

NIPPON KOEI

6. Progress of Activities

- **Output 1**

Hydrological Monitoring Network Update in accordance with the Purpose of Observation

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

1. **Flood and Drought information** was collected for the period from 2015 to 2023. There were 15 cases of flood and 14 cases of drought. Those information are as listed from the next slides.
2. **News paper articles** were also collected from the period of April 2022 to March 2023. Flood and drought related articles were collected. Of the total 48 articles collected, 25 were drought related one was related to flood, and others were related to: water, food security, climate change etc. Articles are still collected and to be compiled up to the mid of September2024.

NIPPON KOEI

6. Progress of Activities

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

Summary of Flood and Drought Incidents Tana Basin

Flood Incidences

No.	Date	Comments	Area	Impact	Link
F1	18th December 2015	Kenya Red Cross dispatches relief food to Tana River flood victims	Handaraku	2440 households and 15,000 people affected	https://www.kbc.co.ke/kenya-red-cross-dispatches-relief-food-to-tana-river-flood-victims/
F2	10 April 2017	**Farmers In Garissa Counting Losses After River Tana Burst Its Banks**	Sankuri, Balich	Crops swept away , 14 families marooned by flood water	https://www.citizen.digital/news/farmers-in-garissa-counting-losses-after-river-tana-burst-its-banks-163211
F3	10th April 2018	Death toll from Tana River floods rises to 6 after body of woman is found	Bakuyu, Bura Town, Madogo, Mororo	Loss of lives, 400 families displaced	https://barakafm.org/2018/04/10/death-toll-from-tana-river-floods-rises-to-6-after-body-of-woman-is-found/
F4	12th April 2018	**Five killed in Tana River Flooding**	Bilbil	Loss of lives- 2 small boys	https://infonile.org/en/2018/04/five-killed-in-tana-river-flooding/
F5	3rd May 2018	**Schools fail to reopen as rains persist**	Secondary schools:Kipini, Daku, Waldena, Galole Model, Nanighi. Primary schools: Bangale, Huruma, Furaha, Mapenzi, Hurara, Chewani, Hola, Rafiki, Mbalambala, Mulanjo, Ziwani, Mororo, Hatata. Other schools: Kalalani, Kanelati, Titila, Dada, Makadala, Wayuboru, Wayuduka, Kottila, Haroresa, Galili, Idhowe, Gamba, Odole, Kilelengawani, Ozi, Hewani, Wema	Schools shut down/partially closed; classrooms marooned and others destroyed, pit latrines sink	https://www.standardmedia.co.ke/amp/health-science/article/2001279028/schools-fail-to-reopen-as-rains-persist

NIPPON KOEI

6. Progress of Activities

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

No.	Date	Comments	Area	Impact	Link
F6	8th May 2018	**Tana River Residents In Distress**	Gamba (Bandi & Gatheri villages)	32 villages sunk by flood water, 30,000 homesteads destroyed, 64,000 people displaced	https://www.citizen.digital/news/tana-river-in-distress-as-homes-submerged-in-floods-199417
F7	18th May 2018	**KenGen: We are not to blame for Garissa, Tana River floods**	Garissa, Tana River	IDPs, flooded homes and destruction of properties	https://www.businessdailyafrica.com/bd/news/kengen-we-are-not-to-blame-for-garissa-tana-river-floods-2203704
F8	18th May 2018	**Red Cross situation report on 'KenGen floods'**	Garissa, Tana River, Kitui Counties	97 people injured, 186 lost their lives(exclusive of deaths related to disease outbreaks), infrastructure damaged and crucial services such as transportation and health paralyzed, 68780 acres of farmland submerged in water and crops destroyed.	https://reliefweb.int/report/kenya/kenya-floods-mdrke043-operations-update-no-1
F9	19th Novembe r 2019	Over 3,000 People In Garsen Are Marooned Following The Bursting Of River Handarakulagha	Konemasa,Katsangi,Handarak u,Semi-karo (S.L)	Road network cut-off, over 3,000 people marooned,national exams disrupted	https://www.kenyanews.go.ke/over-3000-people-in-garsen-are-marooned-following-the-bursting-of-river-handarakulagha/
F10	24th Decembe r 2019	**Locals in distress as floods submerge villages in the Tana delta**	Mwanja, Odhole, Samicha, Handaraku, Sogan	Submerged homes, several families displaced	https://www.the-star.co.ke/counties/coast/2019-12-24-locals-in-distress-as-floods-submerge-villages-in-the-tana-delta/
F11	27th April 2020	Floods Wreak Havoc In Ijara And Tana River	Tana River- Mikinduni, Kilindini : Ijara Garissa - Mansabubu, Gababa, Masalani,Boji	Crops swept away, transport network cut off, several families affected	https://www.kenyanews.go.ke/floods-wreak-havoc-in-ijara-and-tana-river/
F12	28th April 2020	Floods paralyze transport in Tana river leaving hundreds stranded	Dukanotu	Roads completely cut off, over 500 households affected	https://barakafm.org/2020/04/28/floods-paralyze-transport-in-tanariver-leaving-hundreds-stranded/

6. Progress of Activities

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

No.	Date	Comments	Area	Impact	Link
F13	10th May 2020	Heavy rains destroy homes, cause landslides in Murang'a	Kagarii -Gatanga; Mariira-Kiharu; Maporomoko-near Thika; Mioro; Murarandia-Kahuru	Several families displaced and homes destroyed	https://www.the-star.co.ke/counties/central/2020-05-10-heavy-rains-destroy-homes-cause-landslides-in-muranga/
F14	15th May 2020	3,000 residents stranded in Tana Delta floods	Mwanja, Odhole, Samicha, Handaraku, Kikomo villages	7000 people displaced, 3000 others stranded in flooded villages	https://www.the-star.co.ke/news/2020-05-16-3000-residents-stranded-in-tana-delta-floods/
F15	6th April 2021	Tana River Residents Decry The State Of Impassable Road	Bilbil	Lack of basic commodities due to broken road network	https://www.kenyanews.go.ke/tana-river-residents-decry-the-state-of-impassable-road/

Drought Incidences

No.	Date	Comments	Area	Impact	Link
D1	14th March 2017	Garissa fights disease, hunger, in long drought	Fafi, Balambala	Famine leading to starvation and malnutrition, lack of pasture deteriorating livestock health	https://www.hiiraan.com/news4/2017/Mar/141031/garissa_fights_disease_hunger_in_long_drought.aspx
D2	28th February 2021	Garissa faces severe water crisis as drought worsens	Bahuri-Dadaab; Abdisamat, Shimbirey,Shentabacaad-Balambala; Lagdera,Ijara, Hulgho	water pans dried up and boreholes broken down	https://www.the-star.co.ke/counties/north-eastern/2021-02-28-garissa-faces-severe-water-crisis-as-drought-worsens/
D3	18th June 2021	**Water shortage hits Tana River, locals pray for rainfall**	Garsen town and its environs	Households use so much money to get little water, Water from TIS causes infections among children	https://www.standardmedia.co.ke/counties/article/2001415994/water-shortage-hits-tana-river-locals-pray-for-rainfall

6. Progress of Activities

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

No.	Date	Comments	Area	Impact	Link
D4	6th Septembe r 2021	**Over 60,000 people facing starvation in Tana River county**	Tana North- Lakole, Hosingo, Titila Tana River- Gururi, Goticha, Wayu-Duka, Haroresa	Severe food and water shortage;63,000 people hunger stricken and water sources have dried up	https://www.standardmedia.co.ke/coast/article/2001422756/over-60000-people-facing-starvation-in-tana-river-county
D5	7th Septembe r 2021	The agony of Assa village in Tana River County as drought bites	Assa-Garsen	Hunger & starvation, disruption of normal routine in search of water such as schooling	https://thecounty.co.ke/the-agony-of-assa-village-in-tana-river-county-as-drought-bites/
D6	30th Septembe r 2021	**Pastoralists lose livestock as drought ravages Tana Delta**	Bula-Tarrassa	Death of livestock	https://www.standardmedia.co.ke/north-eastern/article/2001424897/pastoralists-lose-livestock-as-drought-ravages-tana-delta
D7	1 October 2021	Meru farmers, Isiolo herders unite to survive drought	Lachathuriu-Tigania west;Tigania East,Maraa-South Imenti;Kamweline,Ithata,Ngitana,Murara,Kachiuru,Nginyo-Igembe North	More than 120000 people in need of food	https://www.breakingkenyanews.com/2021/10/meru-farmers-isiolo-herders-unite-to.html
D8	7 October 2021	Tana River County Drills Boreholes Across County As Part Of Drought Response Initiative	Ngao, Gururi, Waldena, Lakole	Residents walking hundreds of kms in search of water, many households affected by famine	https://shahidinews.co.ke/2021/10/07/tana-river-county-drills-boreholes-across-county-as-part-of-drought-response-initiative/
D9	8th March 2022	Drought Hits Tana River, Residents Seek Food Aid	Tana River County	68,000 people affected due to famine, declined crop and livestock production	https://www.kenyanews.go.ke/drought-hits-tana-river-residents-seek-food-aid/

6. Progress of Activities

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

No.	Date	Comments	Area	Impact	Link
D10	13th June 2022	Children Hit Hard By Drought	23 Arid and semi-arid countries	malnutrition in children due to famine, livestock death, poor health conditions of livestock due to little pasture regeneration	https://www.kenyanews.go.ke/1million-children-malnourished-in-drought-affected-regions/
D11	4th July 2022	'The conflict takes two forms': How worsening droughts are fueling tensions in Kenya	Tana River County- Matanya village, Subo village, Ruko village	Dried water pans, livestock death, conflicts, long search of water and pasture	https://www.thejournal.ie/conflict-over-drought-in-kenya-5805313-Jul2022/
D12	4th July 2022	Red Cross to buy off livestock hit by drought in 14 counties	Tana River County- Tana North, Tana Delta and Tana River sub- counties	Dried water pans, famine, livestock death	https://www.the-star.co.ke/counties/coast/2022-07-04-red-cross-to-buy-off-livestock-hit-by-drought-in-14-counties/
D13	19th Septembe r 2022	Drought worsens in hungry. Thirsty Garissa County	Garissa county- Lagdera, Daadab	Livestock death, close to 378000 people facing starvation, malnutrition, source of livelihood destroyed	https://www.the-star.co.ke/counties/north-eastern/2022-09-19-drought-worsens-in-hungry-thirsty-garissa-county/
D14	1st February 2023	Give us water, not fertilizer; Mt. Kenya farmers say as region suffers food crisis	Embu, Meru, Kirinyaga counties	Lack of food and water(close to 500,00 people starving), failed season crops, livestock death, malnutrition, Human-wildlife conflict	https://nation.africa/kenya/counties/give-us-water-not-fertiliser-mt-kenya-farmers-say-as-region-suffers-food-crisis--4106958

6. Progress of Activities

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

Several YouTube Links are collected for April 2024 Flood

No.	Date	Title of Event	Locations	URL of YouTube
1	4th April 2024	Over 700 families in Kirinyaga facing losses as they grapple with the aftermath of severe flooding	Mwea -Kirinyaga County	https://www.kenyamoja.com/video/over-700-families-kirinyaga-facing-losses-they-grapple-aftermath-severe-flooding-k24-video
2	24th April 2024	Floods: 10 killed in Nairobi	Nairobi	https://www.youtube.com/watch?v=j9mOEgIYLC0
3	24th April 2024	Athi River breaks its banks	Machakos county	https://www.youtube.com/watch?v=1SvoJd8MeKo&t=16s
4	24th April 2024	Floods aerial view	24 Counties affected by floods	https://www.youtube.com/watch?v=r1bl_g_oUX4
5	27th April 2024	Floods kill 83 people across the country	Several counties across the country	https://www.youtube.com/watch?v=67NDSVqITSo

6. Progress of Activities

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

3. As one of **countermeasures against flood**, **Riparian Marking** is being executed by WRA. The following pictures show activites initiated by Muranga sub-basin office.


Riparian marking activities in Muranga sub-region (during June to August 2022)


Riparian marking activities in Muranga sub-region (during June to August 2022)


Riparian marking activities in Muranga sub-region (during June to August 2022)

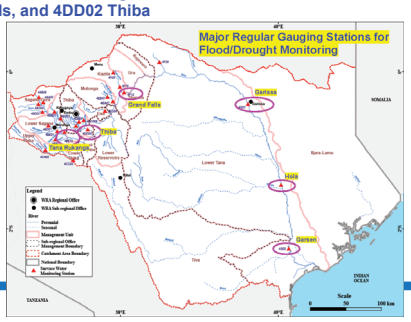

Sensitization meeting for riparian marking by WRA Muranga SRO (during June to August 2022)

6. Progress of Activities

Activity 1-1: Survey on recent flood and drought damages as well as countermeasures for such damages.

4. As one of **countermeasures against Drought**, **Rationing Activities** are being executed by WRA.
5. As one of **countermeasures against flood and drought**, the following six regular gauging stations are used for monitoring:

4BE10 Tana Rukanga, 4G01 Garissa, 4G04 Hola, 4G02 Garsen, 4F13 Grand Falls, and 4DD02 Thiba



6. Progress of Activities

- **Output 1**

Hydrological Monitoring Network Update in accordance with the Purpose of Observation

Activity 1-2: Survey on **support activities by other development partners.**

So far JICA Experts Team surveyed other development partners' activities as follows:

1. Kenya Water Security and Climate Resilience Project (**KWSCRP**) supported by the World Bank: Flood warning system and watershed management components of **Nzoia River** in the Lake Victoria North Basin Area
2. Capacity Development for Effective Flood Management in Flood Prone Area (**CDEFM**) implemented by **JICA from 2011 to 2014**, and Flood Control Officers (FCO) in WRA: Completed.
3. **Groundwater survey by USAID** in South Turkana and Marsabit
4. Monitoring for Information and Decision using Space Technology (**MIDST**)
5. Nairobi Water Fund (**NWF**)
6. **Blue Deal** Upper Tana

6. Progress of Activities

- **Output 1**

Hydrological Monitoring Network Update in accordance with the Purpose of Observation

Activity 1-3: Clarification on the positions/purposes of each observation station from the viewpoint of flood and drought risk evaluation.

1. Status of Regular Gauging Stations

Status of Regular Gauging Stations in Tana Basin Area

	Total	Operational	Not Operational	Telemetering Station	Data Logger	Vandalized	Need Rehabilitation
Kerugoya	13	13	0	7 (54%)	0	1	2 (15%)
Muranga	53	47	6	11 (21%)	19 (36%)	7	14 (26%)
Meru	16	13	3	3 (19%)	4 (25%)	0	0
Sub-total	**82**	**73**	**9**	**21 (26%)**	**23 (28%)**	**8**	**16 (20%)**
Garissa	5	3	2	1 (20%)	0	0	0
Total	**87**	**76**	**11**	**22 (25%)**	**23 (26%)**	**8**	**16 (18%)**

It was realized Tana Basin Area observes 87 stations against recommended 26 stations in NWMP 2030.

Muranga has the largest number of stations as 53.

The reason to keep 87 stations should be clarified for more effective management considering available resources.

6. Progress of Activities

- **Output 1**

Hydrological Monitoring Network Update in accordance with the Purpose of Observation

Activity 1-4: Review of monitoring plan of Tana Catchment Area from the viewpoint of effective utilization of the observation results.

1. As a result of review of the current status of Regular Gauging Stations (RGS), the objectives of monitoring and available resources should be re-examined.

6. Progress of Activities

- **Output 2**

Capacity Building on Hydrological **Monitoring**

Activity 2-1: Confirmation on operational status and analysis of issues on Observation Facilities and Data Transmission Facilities

1. Confirmation of the status of Data Logger provided by previous JICA Expert activities. Four data loggers were provided by previous JICA Expert Activities (2017-2019)

The status is as follows:

- One is installed at **4F10 Kathita** in Meru SRO, but the equipment was **stolen before May 2023**. One was installed at **4BE10 Tana Rukanga** in 2018, but it was **vandalized in June 2021**. The equipment was taken away. The station is left as it is (non-functional).
- One is **kept at Garissa SRO.**
- One is **kept at Muranga SRO**.

Vandalism is one of the challenges of WRA.


Checking the status of Data Logger provided by the previous JICA advisory activity.


Status of the Data Logger yet to be installed.

Data Logger (Hioki) kept at Muranga SRO.

6. Progress of Activities

Activity 2-1: Confirmation on operational status and analysis of issues on Observation Facilities and Data Transmission Facilities

2. Analysis of issues on Observation Facilities and Data Transmission Facilities

(1) Telemetering Equipment

- Of the 22 Telemetering Stations in Tana Basin, JICA Experts Team visited five stations in October 2021.
- Three stations are well functioning with SEBA system, namely, 4DA11 Thiba, 4BB01 Ragati, and 4CC08 Thika.
- One station was vandalized with the door broken at 4BE10 Tana Rukanga.
- One station with ISODAQ system was not functioning at 4DD02 Thiba.

(2) Data Logger

- Of the 23 Data Loggers in Tana Basin, JICA Experts Team visited one station in June 2022, namely 4BE01 Maragua. This station is also telemeterized but monitoring by Data Logger and manual gauge reading is also being done.

6. Progress of Activities

(1) Telemetering Equipment

- Three stations are well functioning with SEBA system, namely, 4DA11 Thiba, 4BB01 Ragati, and 4CC08 Thika.


Photo-01: Gauging Station House

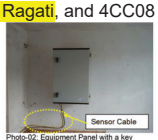


Photo-02: Equipment Panel with a key

Photo-03: Inside of the Equipment Panel

Photo-04: Data logger (SEBA in Germany)

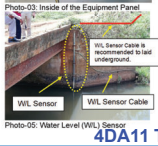


Photo-05: Water Level (W/L) Sensor


Photo-06: Staff Gauge

4DA11 Thiba


Photo-01: Gauging Station House


Photo-02: Equipment Panel: Data logger (SEBA in Germany) and Car battery


Photo-03: Equipment Diagram

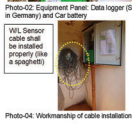


Photo-04: Workmanship of cable installation


Photo-05: Old Water Level (W/L) Sensor and Staff Gauge


Photo-06: Reinstalled W/L sensor

4BB01 Ragati

6. Progress of Activities

(1) Telemetering Equipment

- Three stations are well functioning with SEBA system, namely, 4DA11 Thiba, 4BB01 Ragati, and 4CC08 Thika.


Photo-01: Gauging House


Photo-02: Data logger (SEBA) and Car battery


Photo-03: Equipment is supported with wood


Photo-04: Water Level (W/L) Sensor


Photo-05: W/L sensor cable is exposed


Photo-06: Staff Gauges

4CC08 Thika

6. Progress of Activities

(1) Telemetering Equipment

- One station was vandalized with the door broken at 4BE10 Tana Rukanga.


Photo-01: Signboard of the Project


Photo-02: Gauging House is vandalized


Photo-03: Staff Gauges (in total 6 pcs)


Photo-04: Past Flood Level

4BE10 Tana Rukanga

6. Progress of Activities

(1) Telemetering Equipment

- One station with ISODAQ system was not functioning at 4DD02 Thiba.


Photo-01: Gauging House

Photo-02: Sedimentation of sand/mud due to past flood inside the gauging house


Photo-03: Data logger (ISODAQ), There is nest inside


Photo-04: Nest of bees inside of the gauging house


Photo-05: Water Level Sensor


Photo-06: Staff Gauges, one is stolen

4DD02 Thiba

6. Progress of Activities

(2) Data Logger

- Of the 23 Data Loggers in Tana Basin, JICA Experts Team visited one station in June 2022, namely 4BE01 Maragua. This station is also telemeterized but monitoring by Data Logger and manual gauge reading is also being done.
- The installed Data Logger is called HOBO.
- The data retrieval using USB cable is easy and quick. It is recommended to install this system.


Photo-01: Gauge House


Photo-02: Structure for the water level gauge


Photo-03: Structure for the water level gauge (box)


Photo-04: Inside of the Box


Photo-05: Water level data logger (HOBO)


Photo-06: Data reading from the water level data logger to notebook PC though the coupler

4BE01 Maragua

6. Progress of Activities

Activity 2-1: Confirmation on operational status and analysis of issues on Observation Facilities and Data Transmission Facilities

2. Analysis of issues on Observation Facilities and Data Transmission Facilities

(1) Telemetering Equipment

- As a result of site visit, Telemetering Equipment of **SEBA is functioning very well**. It is recommended to install this system as it seems this system is **more reliable compared with other systems**.

(2) Data Logger

- Of the four Data Loggers provided by JICA two are installed but stolen/vandalized. It is **necessary to install two more** which are kept at Garissa and Muranga offices.
- JICA Experts Team visited one station in June 2022, namely 4BE01 Maragua. The **Data Logger HOBO is reliable, easy to handle.**

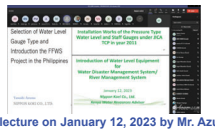
6. Progress of Activities

- **Output 2**

Capacity Building on Hydrological **Monitoring**

Activity 2-3: Training of Observation Facilities and Data Transmission Facilities

1. **A preliminary online lecture** was held in **January 2023** by Telemetering Expert Mr. Azuma. There were 20 participants, namely six from WRA headquarters, nine from Tana Basin Area, and five from JICA Experts Team.



Online lecture on January 12, 2023 by Mr. Azuma

2. **Target monitoring stations for Transmission Facilities Training**

The following stations are selected as reference stations for telemetric capacity building training and formulation of training manuals for establishment of a framework for Water Allocation Planning (WAP) and a Flood and Drought Early Warning System (F&D EWS) template.

4AC03 River Sagana, 4BC02 River Tana at Sagana, 4BB01 River Ragati and 4BE01 River Maragua

6. Progress of Activities

- **Output 2**

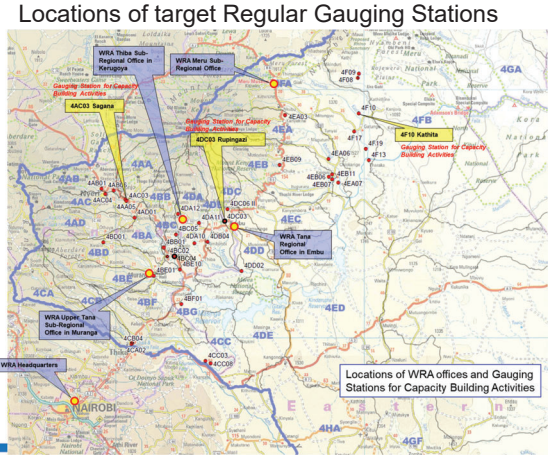
Capacity Building on Hydrological **Monitoring**

Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve

1. This work item is done through **on-site** discharge measurement and river cross section survey (It is scheduled to conduct these activities for four times.).
2. In the original work plan this works were to be sublet and to be done by local company who was good at discharge measurement and river cross section survey.
3. However, WRA rejected the idea of JICA Experts Team, i.e., subletting and WRA mentioned they would do themselves.
4. In total, **Discharge Measurement** and **River Cross Section Survey** were jointly conducted by WRA and JICA Experts Team **Four Times**.
5. Target regular gauging stations for training are: **4DC03 Rupingazi** (Kerugoya Sub-Region), **4AC03 Sagana** (Muranga Sub-Region), and **4F10 Kathita** (Meru Sub-Region).

6. Progress of Activities

- Locations of target Regular Gauging Stations



6. Progress of Activities

Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve

1. The **first** activities of discharge measurement and river cross section survey were conducted in **March to April 2022**.

Date 17 March 2022 09:00 a.m.
Description: Checking the equipment at Kerugoya SRO

Date 18 March 2022 11:55 a.m.
Description: Discharge Measurement at RGS (4DC03 Rupingazi)

Discharge measurement at 4DC03 Rupingazi

6. Progress of Activities

Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve

1. The **first** activities of discharge measurement and river cross section survey were conducted in **March to April 2022**.

Date 29 March 2022 00:41 p.m.
Description: Discharge measurement at RGS (4AC03 Sagana)

Date 29 March 2022 01:13 p.m.
Descrptipion: Cross section survey using leveling equipment at RGS (4AC03 Sagana)

Discharge measurement at 4AC03 Sagana

6. Progress of Activities

Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve

1. The **first** activities of discharge measurement and river cross section survey were conducted in **March to April 2022**.

Date 31 March 2022 00:37 p.m.
Description: Dischargeme Measurement at RGS (4F10 Katita)

Date 31 March 2022 00:46 p.m.
Description: Current meter (procured in the previous project) at RGS (4F10 Katita)

Discharge measurement at 4F10 Kathita

6. Progress of Activities

Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve

2. The **second** activities of discharge measurement and river cross section survey were conducted in **December 2022.**

3. The **third** activities were conducted in **May 2023**.

Date and time: 12:00, 23/05/2023
Location: RGS 4AC03 Sagana River
Description: Measuring flow velocity

Date and time: 12:00, 23/05/2023
Location: RGS 4AC03 Sagana River
Description: Measuring water level/flow velocity

Discharge measurement at 4AC03 Sagana

6. Progress of Activities

Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve

3. The **third** activities were conducted in **May 2023**.

Date and time: 12:00, 23/05/2023
Location: RGS 4AC03 Sagana River
Description: Measuring flow velocity

Date and time: 12:00, 23/05/2023
Location: RGS 4AC03 Sagana River
Description: Checking the measuring current meter point (0.6 x water depth)

Discharge measurement at 4AC03 Sagana

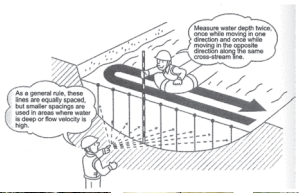
6. Progress of Activities

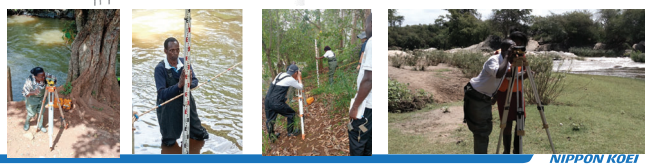
Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve

4. The **fourth** activities were scheduled to be conducted in **November 2023,** however, due to high water level, the works were **postponed until February 2024.**

6. Progress of Activities

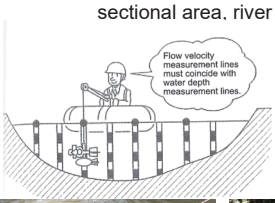
- Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve
  - River Cross Section Survey
    - Setting up level and reading the staff along the river.

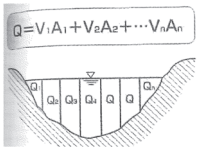


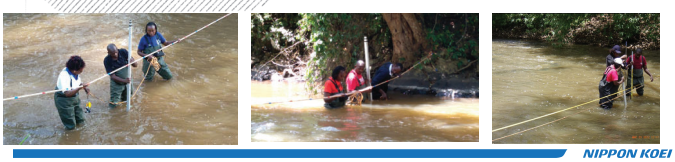


6. Progress of Activities

- Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve
  - Discharge Measurement
    - By summing up measured velocity multiplied by each sectional area, river discharge can be calculated.

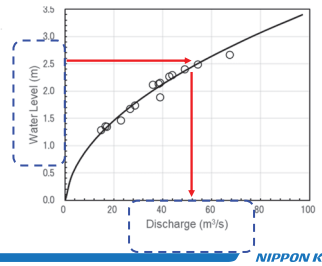






6. Progress of Activities

- Activity 2-4: Reinforcement of Capacity on Observation at site including preparation of H-Q Curve
  - Preparation of H-Q Curve
    - With accumulation of H, Q data, H-Q curve is prepared.
    - If the water level is observed, by converting the water level (H) to discharge (Q) using H-Q curve, the discharge can be estimated.



6. Progress of Activities

- Number of times for river cross section survey and discharge measurement
  - 1st activities: March 2022
  - 2nd activities: December 2022
  - 3rd activities: May 2023
  - 4th activities: February 2024
    - February 7 (Wednesday) at 4AC03 Sagana
    - February 8 (Thursday) at 4DC03 Rupingazi
    - February 9 (Friday) at 4F10 Kathita

* During October and November 2023, JICA Experts Team tried 4th activities for measurement, but due to high water level, it was not possible.


6. Progress of Activities

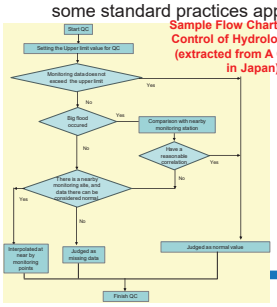
- **Output 3**

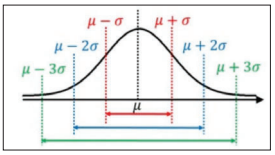
Capacity Building on **Arrangement and Storage** of Hydrological and Meteorological Data

Activity 3-1: Quality Improvement Guidance and Preparation of Quality Control Standard

During the meeting with WRA in June and July 2024, it was found that there is no standardized method for quality control. JICA Experts Team introduced some standard practices applied in Japan.

Sample Flow Chart of Quality Control of Hydrological Data (extracted from A Guideline in Japan)





Concept of defining upper and lower limits for outliers (abnormal value)

6. Progress of Activities

- **Output 3**

Capacity Building on **Arrangement and Storage** of Hydrological and Meteorological Data

Activity 3-2: Confirmation on the Current Status and Improvement on Operation and Management of Database

JICA Experts Team confirmed that WRA carry out operation and management of Database based on the Quality Management Systems without any problems. However, data storage records including quality control records were not stored. Therefore, the JICA Experts Team plans to provide sample checklists.

STATION ID	Station Category	CHECKITEMS																		COMMENTS
		SRO									RO						HQ			
		Data Filling		Data Matching		Expected Data		Paper Filling		e-Data Storing		Data Filling		Data Conversion		e-Data Storing		Data Filling		e-Data Storing	
		YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	ISSUES
4A A06		✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4A A05	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		E-Data storing is not finished at HQ
4A B01	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4A B06	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4A C01	IMU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4A C04	IMU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4A D02	IMU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B B01	IMU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B C02	IMU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B C05	IMU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B D New	Special	✓		✓		✓		✓		✓		✓			✓	✓		✓		✓		Data Conversion is not finished at HQ
4B D02	IMU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B D07	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B E new	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B E new	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B E03	MU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B E03	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B E04	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B E06	Special	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		
4B F10	MU	✓		✓		✓		✓		✓		✓		✓		✓		✓		✓		

A part of sample checklist for data storage records

6. Progress of Activities

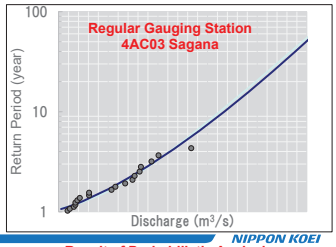
- **Output 4**

Capacity Building on **Analysis and Utilization** of Hydrological and Meteorological Data

Activity 4-1: Guidance on Basic Analysis: Implementation on Flow Regime Arrangement/Compilation and Probabilistic Analysis

This activity was carried out as a training session in June 2024 using Microsoft Excel. Participants recognized that frequency analysis is highly dependent on the results of daily monitoring. Participants came to know the importance of daily monitoring, quality control, and data storage through this exercise.

Guidance lecture in Embu on June 10,2024



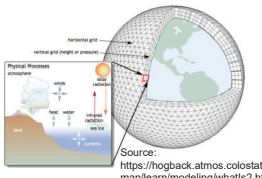
Result of Probabilistic Analysis

6. Progress of Activities

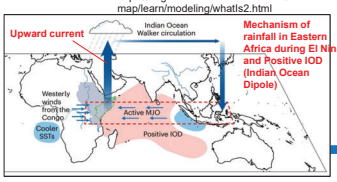
- **Output 4**

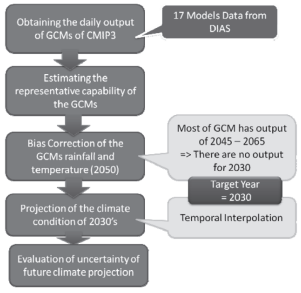
Activity 4-2: Analysis Climate Change Affect

JICA Experts Team conducted lectures for "Analysis Flow of the Climate Change" on October 13, 2024, and "Climate Variability" on June 10, 2024, respectively.



Source: https://hogback.atmos.colostate.edu/cmap/learn/modeling/whatls2.html





Work Flowchart of Climate Change Analysis

6. Progress of Activities

- **Output 4**

Activity 4-2: Analysis Climate Change Affect

Methodologies adopted in the National Water Master Plan 2030 (NWMP 2030)

- Selected 11 GCMs

No.	GCMs Name	Correlation P	Correlation Olr	Correlation SLP	Correlation TAS	RMSE P	RMSE Olr	RMSE SLP	RMSE TAS	Selected for Calculation
1	ccsm4_cgcm3_1									Selected
2	ccsm4_cgcm3_1_t63									Selected
3	cnrm_cm3									Selected
4	csiro_mk3_0									Selected
5	csiro_mk3_5								1	
6	gfdl_cm2_0									Selected
7	gfdl_cm2_1									Selected
8	giss_aom	1								
9	giss_model_e_r	1						1		
10	inp_fgoals1_0_g		1		1				1	
11	ingv_echam4			1						
12	ipsl_cm4									Selected
13	miroc3_2_hires									Selected
14	miroc3_2_medres									Selected
15	mnib_echo_g			1						
16	mpi_echam5									Selected
17	mri_cgcm2_3_2a									Selected

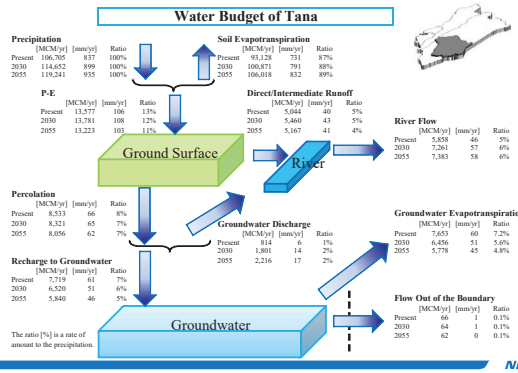
Note: In the RMSE and Correlation, the cells inscribed "1" means the model abandoned through the evaluation.
RMSE (Root-mean-square error)
P : Precipitation
Olr :Outgoing Longwave Radiation
SLP :Sea Level Pressure
TAS :Surface Air Tempreture
Source: Evaluated by JICA Study Team with the data obtained from Data Integration and Analysis System (DIAS) dataset, and The Phase 3 of Coupled Model Intercomparison Project (CMIP3) multi-model dataset.

6. Progress of Activities

- **Output 4**

Activity 4-2: Analysis Climate Change Affect

Results of Climate Change Analysis in the National Water Master Plan 2030 (NWMP 2030)



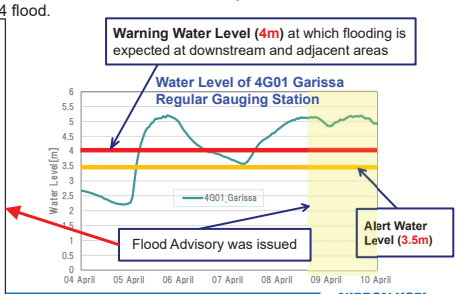
6. Progress of Activities

- **Output 4**

Capacity Building on **Analysis and Utilization** of Hydrological and Meteorological Data

Activity 4-3: Discussion and Compilation on the Function of WRA as well as Utilization of Monitoring Results aiming at Flood Damage Mitigation

JICA Experts Team confirmed that 4G01 Garissa Water Level monitoring results and KMD weather forecasts were used for the Flood Damage Mitigation of Tana Basin area. Then the team discussed with WRA about further necessary measures based on lessons learned from the April 2024 flood.



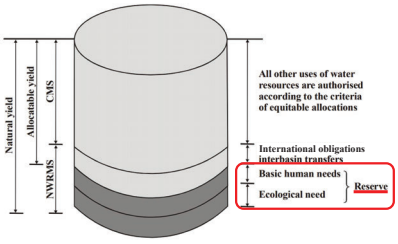
WRA issued Heavy Flood Advisory on April 9, 2024

6. Progress of Activities

- **Output 4**

Activity 4-4: Discussion and Compilation on the Measures during Droughts as well as Utilization and Analysis of Monitoring Results

JICA Experts Team confirmed that measures during droughts are carried out based on water allocation guidelines. It is implemented in full consultation with the WRUA and other stakeholders. Monitoring results are used for setting Reserve Quantity (Q95) of each sub-basin.



Discussion with water rights officers of Muranga Sub-Basin Office, WRA

6. Progress of Activities

- **Output 4**

Capacity Building on **Analysis and Utilization** of Hydrological and Meteorological Data

Activity 4-5: Publication and Notification to Related Organizations on the Hydrological and Meteorological Data

For this activity, Seminars are held in Embu and in Nairobi through invitation of related organizations and stakeholders.

6. Progress of Activities

Activity 4-5: Publication and Notification to Related Organizations on the Hydrological and Meteorological Data

Schedule of Publication and Notification In Embu

1. Schedule:	**September 17, 2024 (Tuesday)**
2. Venue:	**Izaak Walton Inn, Embu**
3. Purpose:	Dissemination of information sharing methods to assumed users of monitoring data and analysis
4. Contents:	1)Introduction of WRA's activities 2) Introduction of JICA Experts Team's activities
5. Participants:	1)WRA: Water Resources Authority 2) JICA: Japan International Cooperation Agency incl. JICA Experts Team 3) Kenya Meteorological Department 4) County Governments 5) Blue Deal Programme 6) WRA Sub Region (Kerugoya, Meru, Embu, Muranga, Kitui, Garissa 7) Kenya Red-cross Regional Office 8) Delmonte 9) NIA: National Irrigation Authority Regional office 10) WRUA 11) County Commissioner

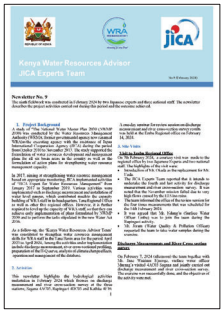
6. Progress of Activities

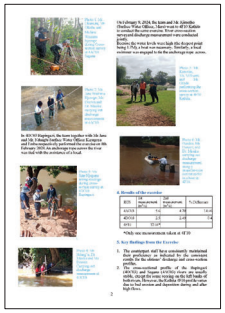
Schedule of Publication and Notification in Nairobi

1. Schedule:	**September 19, 2024 (Thursday)**
2. Venue:	**Fairview Hotel in Nairobi**
3. Purpose:	Dissemination of information sharing / disclosure methods to assumed users of monitoring data and analysis results
4. Contents:	1)Introduction of WRA's activities 2) Introduction of JICA Experts Team's activities
5. Participants:	1) MWSI-Ministry of Water, Sanitation & Irrigation: Water, Irrigation Secretary 2) WRA: Water Resources Authority 3) JICA: Japan International Cooperation Agency incl. JICA Experts Team 4) KMD: Kenya Meteorological Department 5) NIA: National Irrigation Authority, 6) HSK: Hydrological Society of Kenya 7) ACEK: Association of Consulting Engineers of Kenya 8) KSA: Kenya Space Agency, 9) Blue Deal Programme 10) Kenya Red Cross: Kenya Red Cross Society, Nairobi 11) NDMA: National Drought Management Authority 12) NDOC: National Disaster Operations Centre 13) KEWI: Kenya Water Institute 14) AWWDA: Athi Waterworks Development Agency 15) KenGen: Kenya Electricity Generating Company

7. Other Activities

- Newsletter
  - As of the middle of September 2024, JICA Experts Team issued eleven newsletters. The below show newsletter No. 9.





End of Presentation

Water Resources Authority (WRA)

Kenya Water Resources Advisor

Hydrological Monitoring
and
Data Management

September 17, 2024

Overview of WRA's mandate

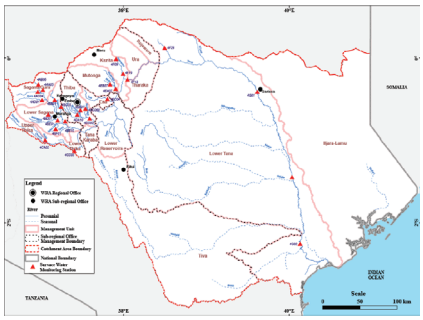
- The Water Resources Authority (WRA) is responsible for the management, regulation, and protection of water resources across the country as espoused in the water Act 2016.
- It ensures sustainable and equitable water resource management
- Achieved through monitoring, regulation and data management.
- Regular monitoring of water levels, discharges and river cross-sectional is critical for drought and flood management
- Monitoring enhances flood and drought preparedness.

Monitoring role of the WRA

- WRA uses a network of hydrological stations to collect water data for forecasting and management.
- Monitoring is essential for sustainable water resource management in Kenya.

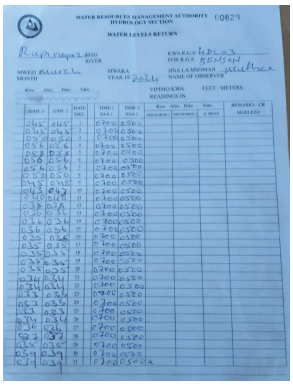
Status of Regular Gauging Stations in Tana Basin Area

	Total	Operational	Not Operational	Telemetering Station	Data Logger	Vandalized	Need Rehabilitation
Kerugoya	13	13	0	7 (54%)	0	1	2 (15%)
Muranga	53	47	6	11 (21%)	19 (36%)	7	14 (26%)
Meru	16	13	3	3 (19%)	4 (25%)	0	0
Sub-total	82	73	9	21 (26%)	23 (28%)	8	16 (20%)
Garissa	5	3	2	1 (20%)	0	0	0
Total	87	76	11	22 (25%)	23 (26%)	8	16 (18%)



Monitoring role of the WRA

- WRA conducts regular water level monitoring every quarter for low, medium, and high flows.
- Gauge readers monitor water levels daily and submit data to SRO monthly
- Rating curves are used to convert gauge heights to discharges for resource management at the sub-basin and basin level



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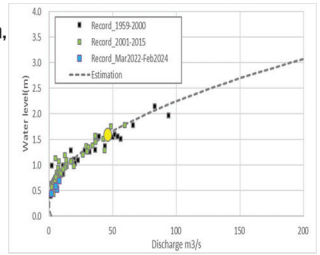
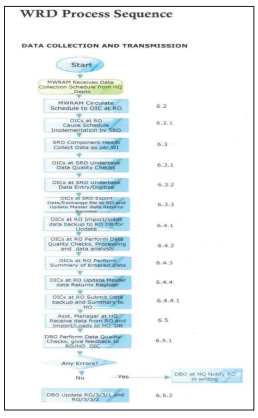


Data Storage/Archiving

- Monthly water level data is digitized and stored on the desktop database at the SRO in Excel
- Hard copy records are stored in respective files at the SRO in designated fireproof metallic cabinets
- Quality checks performed on the data:
  - QMS procedures used for data entry and storage
  - Data checked for consistency, gaps, and outliers
- NB: No data storage and entry checklists are used for quality control and assurance



Source: WRA

Hydrological Data Challenges

- Missing values reduce the credibility of the data
- Data gaps are caused by:
  - Uncollected monthly sheets from the gauge readers,
  - Vandalism
  - RGS washed away
  - Absence of gauge readers
  - Inconsistent recording e.g. weekends and holidays
  - Flows below zero
  - Bridge construction
  - Closure of canals

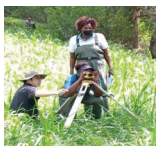
Capacity building activity by the JICA Expert Team

Capacity Building on Hydrological Monitoring

Onsite training

- Four (4) onsite discharge measurements and river cross-section surveys were conducted.
- SWO's capacity enhanced for discharge measurement using ADV and current meters (Seba and propeller-type)
- Staff's capacity to set out survey station using dumpy level for cross-sectional profiles improved
  - evidence of changing channel profiles enhanced the need for regular updating of the rating curve

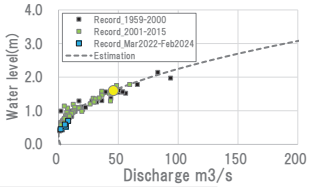


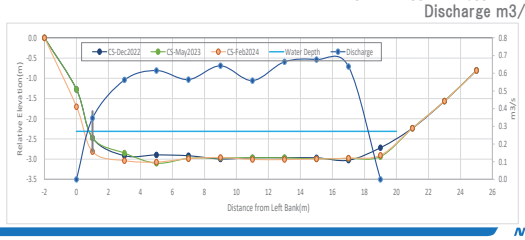



Results of onsite training

Discharge Measurement at Sagana River 4AC03

Date	Gauge height (m)	Discharge (m3/s
29-Mar-2022	0.45	1.73
19-Dec-2022	0.53	6.02
23-May-2023	0.7	7.97
7-Feb-2024	0.59	5.27

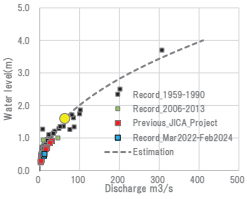


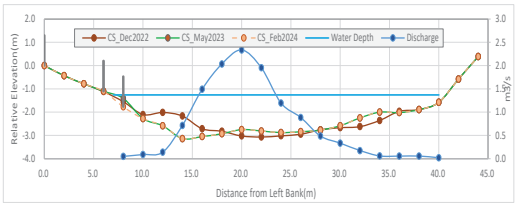


Results of onsite training cont...

Discharge Measurement at Kathita 4F10

Date	Gauge height (m)	Discharge (m3/s	Remarks
14-Dec-2022	0.6	—	No discharge measurments
30-Mar-2022	(Confirming)	5.85	Averaged discharge (5.80m3/s and 5.89m3/s)
18-May-2023	(Confirming)	10.67	Averaged discharge (10.36 m3/s and 10.98m3/s)
9-Feb-2024	0.51	12.04	Measure 1times

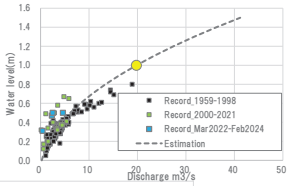


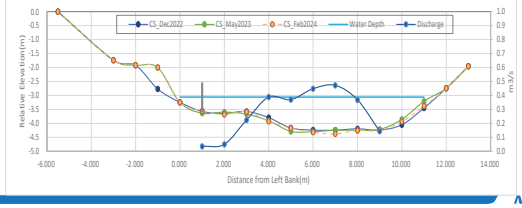


Results of onsite training cont...

Discharge Measurement at Rupingazi 4DC03

Date	Gauge height (m)	Discharge (m3/s	Remarks
18-Mar-2022	0.31	0.425	
9-Dec-2022	0.47	2.34	1st Measurement 2.40 m3/s 2nd measurement 2.28 m3/s
23-May-2023	0.5	4.62	1st measurement 4.64 m3/s 2nd measurement 4.60 m3/s
8-Feb-2024	0.5	2.5	1st measurement 2.50 m3/s 2nd measurement 2.49 m3/s





Capacity Building on Hydrological Monitoring

Training Workshops

- Four workshops were held at the Embu Regional Office
- Key themes trained on in May 2023:
  - Status of data sets in the Tana basin
  - Sources of data
  - RGS reading and maintenance
  - Discharge measurement
    - Measurement depths and intervals


Capacity Building on Hydrological Monitoring

Workshop trainings

- Key themes trained on in October 2023
  - Analysis of climate change trends and impact
  - Hydrological data processing – methods of data gap filling, reliability, and consistency analysis
  - Rating curve development by regression using Excel with solver optimization

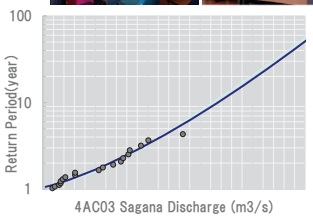


Capacity Building on Hydrological Monitoring

- Key themes trained in February 2024
  - Discharge measurement using Area – velocity method
  - Consideration for spacing intervals during discharge measurement
  - cross-sectional surveys
  - Discharge measurement depth (0.2,0.6 and 0.8)

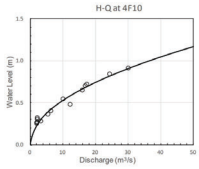
Capacity Building on Hydrological Monitoring

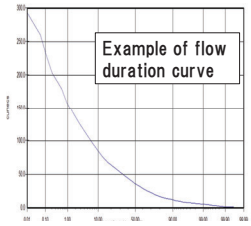
- Key themes trained on in June 2024
  - Frequency analysis of rainfall and discharge
  - Frequency using the GSMaP rainfall
  - Climate variability in East Africa
  - Future climate risk
  - Modelling frequency analysis – Flow duration curves, flood frequency analysis, low flow analysis

Key Achievements from the Trainings

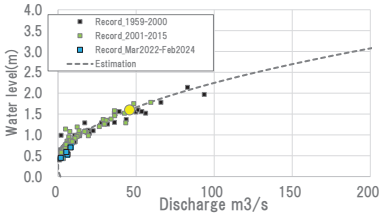
- Staff gained skills to develop rating curves using Excel with solver optimization
- Improved use of discharge measuring equipment i.e. ADV and propeller-type current meter
- WRA staff gained expertise in the development of flow duration curve (FDC) and requisite quantiles for water resources decision-making

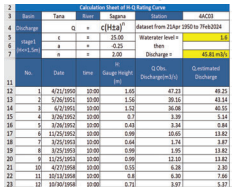




Key Achievements from the Trainings

- Developed a semi-automatic dashboard for rating curve generation in Excel
- Improved drought monitoring through the proficient analysis of low flows
- Improved knowledge of gap-filling using various methods e.g. linear regression, linear interpolation, and trend line in Excel





Utilization of Hydrological Data

- Water situation assessment and reporting at SRO, RO and HQ
- Water allocation planning – equitable water sharing
- Drought monitoring – water sharing during low flows
- Flood advisory (water level monitoring)

END

Thanks for listening

NIPPON KOEI

19

Water Resources Authority (WRA)

Kenya Water Resources Advisor

Real-time Telemetric Data Acquisition and Applications -Tana Basin and New technology incl. Q&A

September 17, 2021

Contents

Status-quo of current situation

Activity 2-1: Confirmation on operational status and analysis of issues on observation facilities and data transmission facilities

1. Observation facilities

(1) Telemetering equipment

- Telemetering equipment consist of telemetry/data logger, battery and water level sensor and gauging house with fence.
- There are mainly two brands, SEBA (Germany brand) and ISODAQ (U.K. brand)
- Performance of the SEBA system is good, meanwhile, ISODAQ is not so.

(2) Data logger

- Data logger called as HOBO (USA brand) is applied to measure as semi-automatic data logging.
- The data retrieval is easy and quick with USB cable at the site.

(3) Data Collection System is established at WRA Headquarter

- Raw data is transmitted from the gauging stations with one hour interval automatically and processed three hours data thru the FTP server.

Status-quo of current situation

2. Data transmission facilities

- Data transmission from the sites to WRA H/Q is utilized for mobile telephone network

3. Issues

- Some stations are not working due to the **vandalism**.
- Maintenance works at some sites are not enough, there is nest inside and sand/mud are remained inside of gauging house.
- Technical section for O&M works of equipment is not established in WRA.
- In case that the equipment is failed, the engineer from H/Q will visit the site for checking and repairing of the equipment,

Output

Output 2: Capacity Building on Hydrological Monitoring

Recommendations of O&M works in June 2022

1) Establishment of the O&M section in each sub-reginal offices and Head quarter
2) Utilization of Ledger List of Equipment
3) Continuous conduct of periodic maintenance work
   - Quarterly regular maintenance
   - Recoding of operational conditions
   - Recoding of malfunction
   - Recording of repair works
   - Quick O&M manual(s)
4) O&M Plan
   - Stock of spare parts and consumable items
   - Training and education

Output

Output 2: Capacity Building on Hydrological Monitoring
Activity 2-3: Training of Observation Facilities and Data Transmission Facilities

1. Online lecture in January 2023

1) Installation works of the pressure type water level sensor
   - Introduction of achievements of pressure type water level sensor in the FFWS Project in the Philippines
2) Selection of Water Level Gauge Type and Introduction the
   - Introduction of water level gauging equipment such as floating, sensing pole, pressure, ultrasonic, radar type
   - Installation examples
   - Required civil works for the installation of water level gauging

2. Activities in January to April 2023

- Tana Grand falls station, RGS 4F13 is selected as subject to the upgrading to a telemetric station.

Output

Output 2: Capacity Building on Hydrological Monitoring
Activity 2-3: Training of Observation Facilities and Data Transmission Facilities

3. Activities in May to August 2023
   - Upgrading to the telemetric station of 4F13 are studied adopting with a Bluetooth device
   - Presentation of system configuration is conducted.

4. Activities in November 2023
   - Study for selection of sites for the proposed pilot stations below- there fluent past hydrological data.
     - 4AC03 River Sagan
     - 4BC02 River Tana at Sagana
     - 4BB01 River Ragati
     - 4BE01 River Mar

Output

Output 2: Capacity Building on Hydrological Monitoring
Activity 2-3: Training of Observation Facilities and Data Transmission Facilities

5. Activities in July to August 2024
   - Lectures for staff of WRA Embu reginal office and sub-reginal offices
     - Presentation of Mike Workstation system
     - Mike Zero Application
     - Telemetry and Related System Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

6. Activities in September 2024
   - Wrap-up of the all activities
   - Final Seminars

Future Issues

1. Improvements of O&M works
   - Establishment of the O&M section in each sub-reginal offices and Head quarter and budget allocation
   - Dedicated O&M contract with a vendor
   - Support on installation of telemetry equipment
2. Utilization of Mike Workstation system and applications
   - Acquirement of additional software license
   - Trainings of the software operations
3. Countermeasures to the vandalism
   - Regular patrol and deployment of keeper of the facilities
   - Desing works
     - Embedded pipe for water level sensor inside of concrete structure
     - Protection of water level sensor with gabion
     - Digging for sensor cable
     - Compact of gauging house

Future Issues

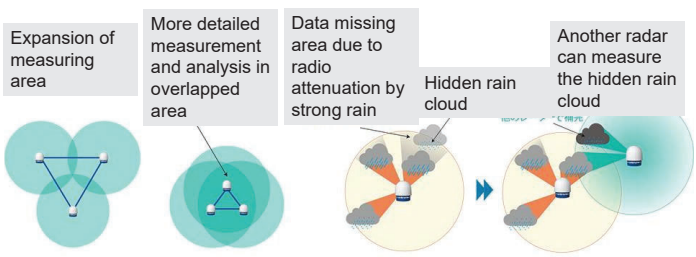
4. Standardizations- it is effective for procurement procedure
   - Specifications of the telemetry equipment/data logger
   - Specifications of the water level sensor (pressure sensor)
   - Desing of civil works and building

5. Acquisition of new technologies for FFW activities
   - Weather Radar (X-band radar)
   - Bluetooth Device
   - Disaster Information Platform

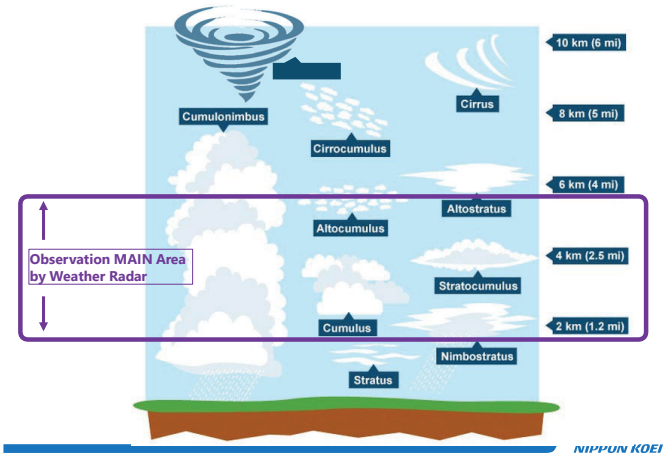
New Technologies for Improvement of Flood Early Waring (FEW) system

It is essential to detect and forecast precipitation in advance for FEW in relevant river basin.

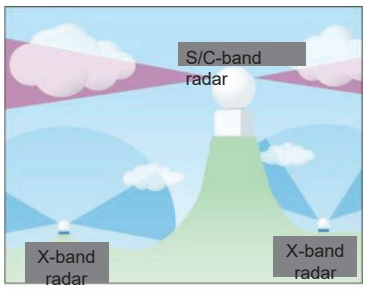
- MP (Multi Politzerization) X-band radar can measure quantitative strength of precipitation
- Plural of X-band radars can measure rainfall in wide area.
- Plural X-band radar can cover hidden rain cloud



Weather Radar



Weather Radar



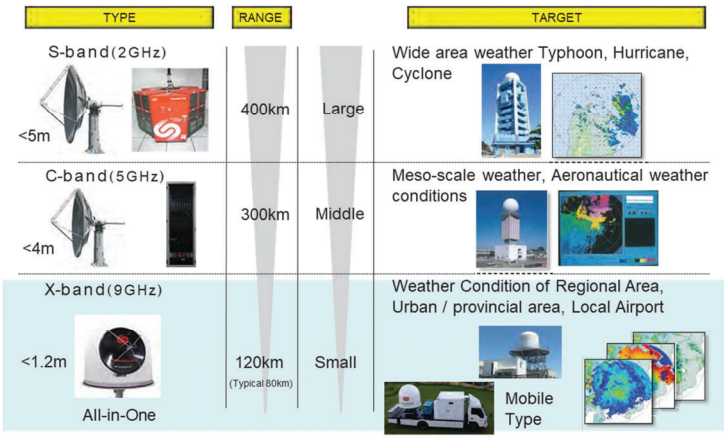
S/C-band radar can measure wide range and high altitude such as typhoon, hurricane, and cyclone, which is used f or weather forecast.

X-band radar, which is installed on top of Steel tower at airport usually, can measure regional weather conditions such as heavens open/guerrilla rainstorm, and heavy rain in small area in city. This can be used for flood forecasting and warning system (FFWS).
In case designated for compact equipment covering 40 km, this can install at roof of such as five stories building instead steel tower

MLIT: Ministry of Land, Infrastructure, Transport and Tourisms in Japan
- 26 sets of C-band radar and 38 sets of X-band radar

https://www.river.go.jp/kawabou/pc/rd?mapType=3&viewRd=1&viewRW=0&viewRiver=1&viewPoint=

Weather Radar



Weather Radar-Comparison of X-band and C-Band radars

Radar type	C-Bad Radar	X-Band Radar
Frequency/ Wave- length	4 – 8 GHz, approx. 5 cm	8 -12 GHz, approx. 3 cm
Purpose of measurement	Live rainfall monitoring (long range)	Live rainfall monitoring (short range) Rain cloud movement observation
Measurement interval	5 min.	1 min.

Weather Radar-Comparison of X-band and C-Band radars

Radar type	C-Bad Radar	X-Band Radar
Time lag	5 – 10 min.	1 – 2 min
Resolution	1 km	150/250 m

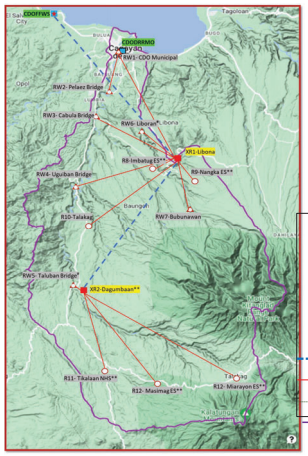
By introducing a high-frequency, high-resolution X-band MP radar in urban areas, we will strengthen on-site observations to reduce damage caused by localized heavy rain

Weather Radar-Comparison of X-band and C-Band radars

Compared to conventional radar (C-band radar), observations can be made at a higher frequency (5 times) and with a higher resolution (16 times).

In addition, the time required for distribution has been reduced from 5 to 10 minutes to 1 to 2 minutes.

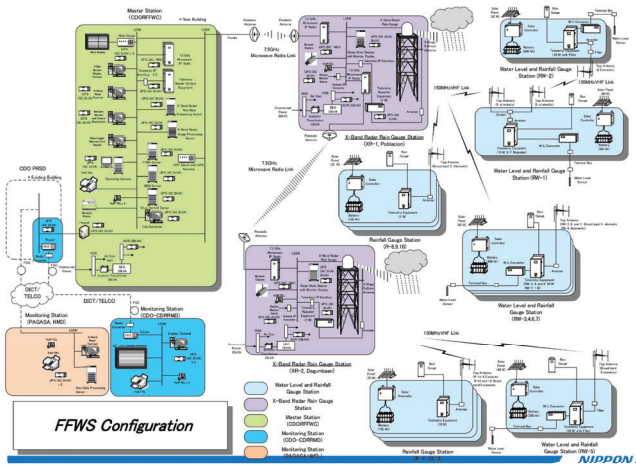
Project Achievement



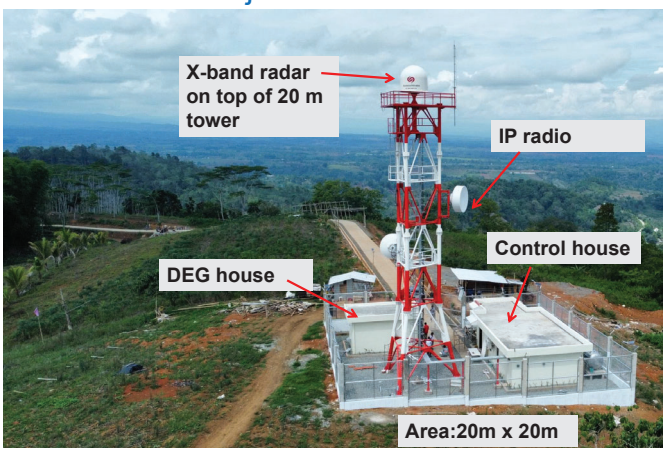
History and General information on the Project:
- Typhoon in 2011 brought 1,250 dead due to flash flood
- River basin area: 1,364 km 2
- Flood reach time from upstream to the CDO city: 7 hours

- Six (6) Rainfall Gauging Station
- Seven (7) Water Level and Rainfall Gauging Station
- Two (2) Radar Rain gauge and Repeater station
- One (1) Monitoring and Control Station
- Two (2) Monitoring Station IP Radio Link
- VHF Telemetry Link Leased line by TELCO
- CDO River basin Boundary

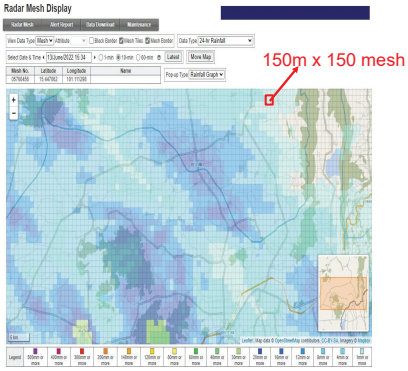
Project Achievement



Project Achievement

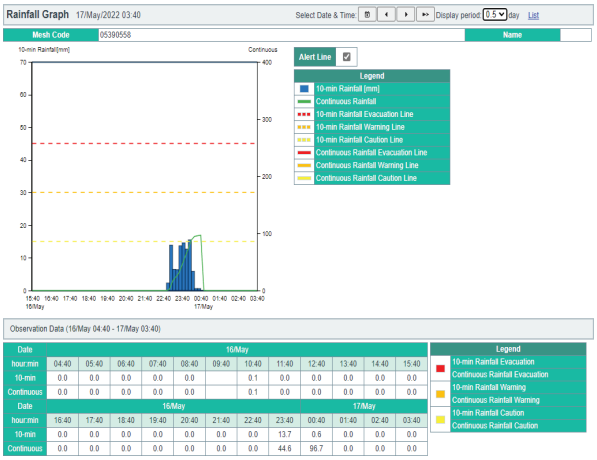


X-Band radar mesh display



Background Color	5/10/15/60-min Rainfall	3-hour/6-hour/24-hour/ Continuous Rainfall
	250 mm or more	500 mm or more
	200 mm ~ 249 mm	400 mm ~ 499 mm
	150 mm ~ 199 mm	300 mm ~ 399 mm
	100 mm ~ 149 mm	200 mm ~ 299 mm
	70 mm ~ 99 mm	140 mm ~ 199 mm
	60 mm ~ 69 mm	120 mm ~ 139 mm
	40 mm ~ 59 mm	80 mm ~ 119 mm
	30 mm ~ 39 mm	60 mm ~ 79 mm
	20 mm ~ 29 mm	40 mm ~ 59 mm
	15 mm ~ 19 mm	30 mm ~ 39 mm
	10 mm ~ 14 mm	20 mm ~ 29 mm
	8 mm ~ 9 mm	16 mm ~ 19 mm
	6 mm ~ 7 mm	12 mm ~ 15 mm
	4 mm ~ 5 mm	8 mm ~ 11 mm
	2 mm ~ 3 mm	4 mm ~ 7 mm
	1 mm	1 mm ~ 3 mm

X-Band radar rainfall



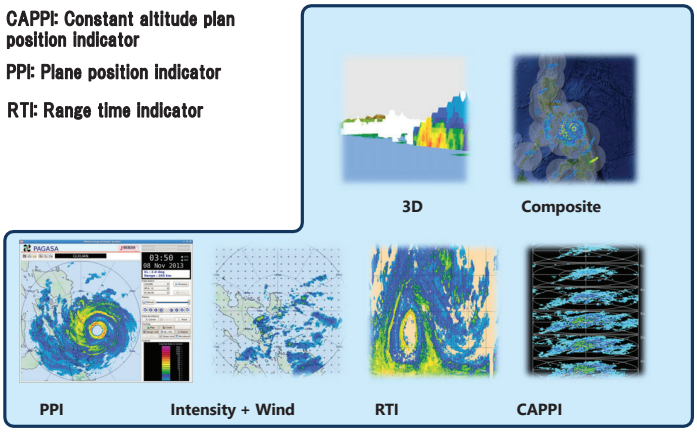
X-Band radar products

One of X-Band radar vendor can provide various products below

CAPPI: Constant altitude plan position indicator

PPI: Plane position indicator

RTI: Range time indicator



X-Band radar products

CAPPI: Constant altitude plan position indicator

The CAPPI gathers the three-dimensional data changing slightly the azimuth angle of the antenna per rotation to the upper side and displays the equal altitude precipitation distribution using the data.

PPI: Plane position indicator

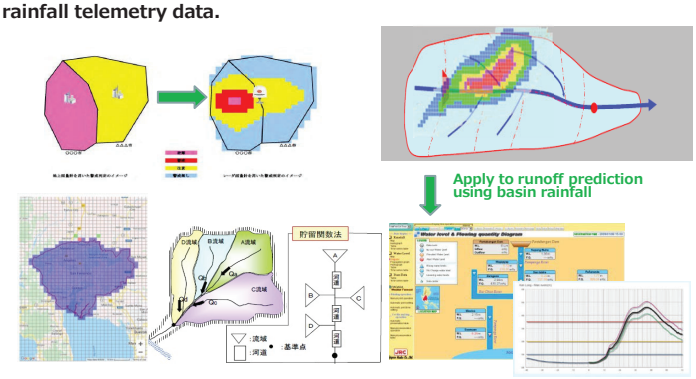
The PPI product shows the distribution of the selected data parameter on a constant elevation angle surface rotating the antenna to the horizontal direction. This is the essential base product of the radar observation.

RTI: Range time indicator

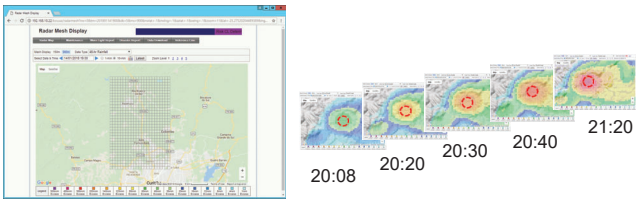
The RTI is most useful for manual scans or “searchlight” scans, which are manual, scan at a fixed position. The horizontal axis is the time (seconds after the beginning of the scan), and the vertical axis is the range from the radar

Output of Calculations

It can calculate sum of mesh data such as basin mean rainfall with high accuracy using radar data, instead of using the observation at points by ground-rainfall telemetry data.



Rainfall warning is generated



60 Min rainfall

Over 30mm/h *Over 70mm/h* *Over 100mm/h* *Over 150mm/h* *Over 200mm/h*

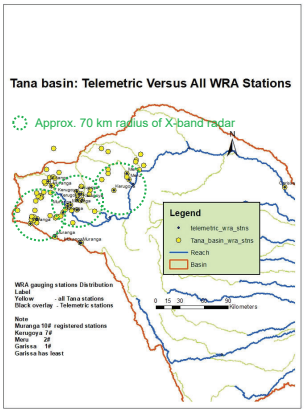
24 Hr. rainfall

Over 40mm/h *Over 70mm/h* *Over 100mm/h* *Over 150mm/h* *Over 200mm/h*

48 Hr. rainfall

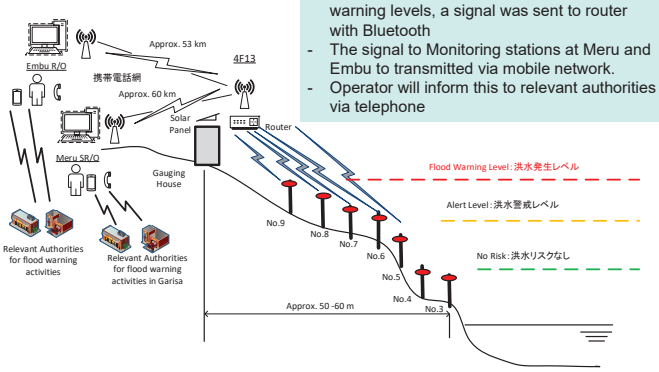
Over 40mm/h *Over 80mm/h* *Over 120mm/h* *Over 150mm/h* *Over 200mm/h*

Coverage with X-band radars for Tana River Basin



Bluetooth Device: Design concept to detect flood for 4F13

Activity on May 2023
- When flood reached at the alert and flood warning levels, a signal was sent to router with Bluetooth
- The signal to Monitoring stations at Meru and Embu to transmitted via mobile network.
- Operator will inform this to relevant authorities via telephone

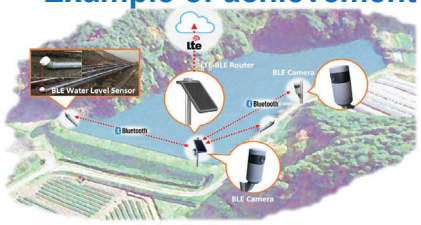


Design concept to detect flood for 4F13

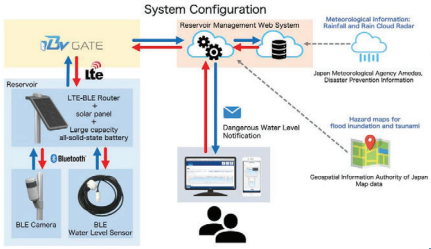
This design was not achieved by the following reasons:

- **JICA Experts Team has contacted to 5 vendors who conducted the verification test by MLIT, on availability of equipment, but no affirmative replies because the equipment are proto-type.**
- **Additional works of updating application from Japanese to English is required (take time and money)**
- **No good/reliable mobile telephone network (new detective telecommunication system is required).**

Example of achievement with Bluetooth



System Configuration



Reservoir Management System: With wireless communication technology, low power consumption.

https://www.braveridge.com/en/product/archives/category/braveridge_monitoring_service

Bluetooth Low Energy (BLE)

Example of achievement with Bluetooth

Low power consumption communication powered by batteries
Bluetooth® Low Energy

Mobile line capable of wide area communication

Bluetooth® × LTE

Make all devices wireless, an independent power supply

Disaster Information Platform

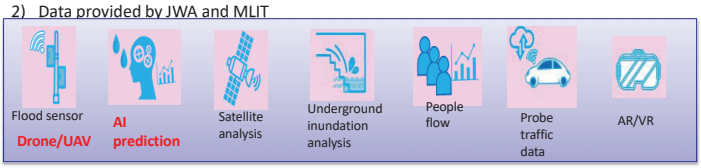
Disaster Information Platform

Client: LGUs, Private Company

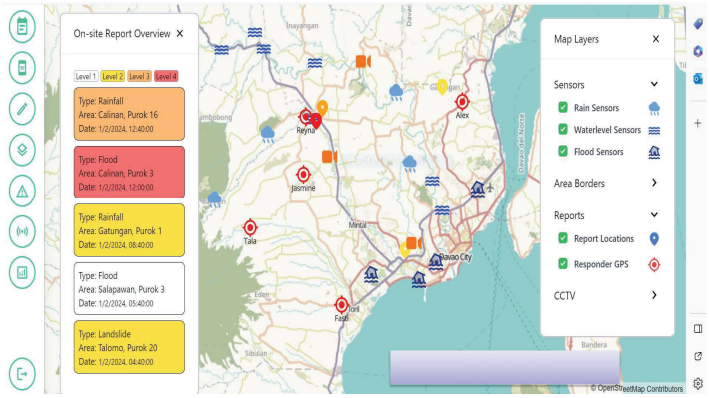
Rainfall runoff, channel routing, and inundation analysis using RRI model[1)]

- Meteorological and hydrological information[2)]
- Flood and landslide information
- Infrastructure and geological information
- Other natural hazard information

1) RRI Model, developed in Japan
2) Data provided by JWA and MLIT

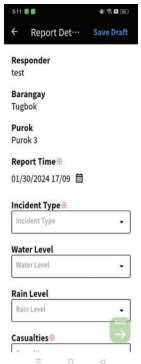


Consolidated View

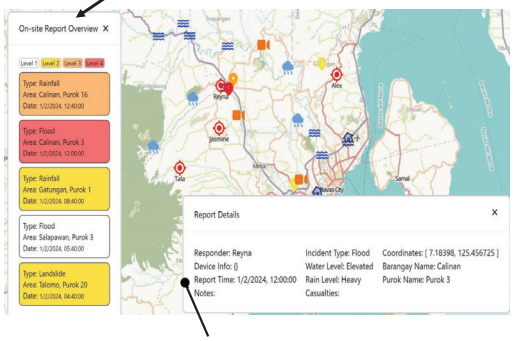


Operation Support Display

Mobile App



Incident List with Priority



Site Situation Report

Flood Prediction

Flood Detection Sensor

Sensor Location

Flood Duration

Flooded Area

Flood Depth

Inundation Analysis

- Could basis one-stop solution for providing flood risk information
- The system provides prediction of water level rising, flow volume, overflow to flood plain by inundation analysis in real-time.
- The analysis can be customized by request.

Thanks

NIPPON KOEI

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Water Resources Authority (WRA)

Kenya Water Resources Advisor

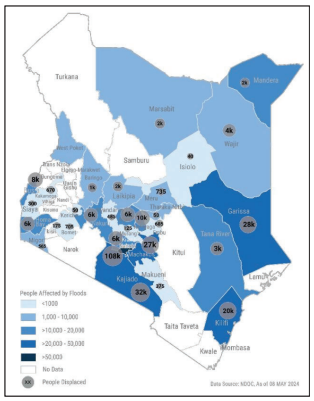
Introduction of Flood Early Warning System and RRI

1.Outline of April 2024 flood
2.Future Climate Risk
3.Introduction of FEWS and RRI

September 17, 2024

1.Outline of April 2024 Flood

1.Outline of April 2024 Flood/Damage Situation of April Flood



Source: OCHA

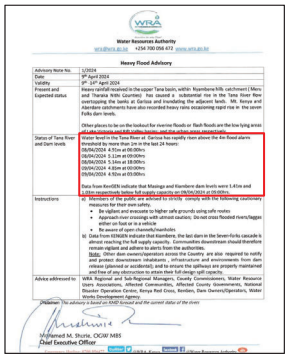
Source: Kenya Red Cross

(as of 10 May 2024)

267	380,573	281,385	42	9,973	41,562
deaths	people affected	people displaced	counties affected	livestock deaths	acres of cropland destroyed

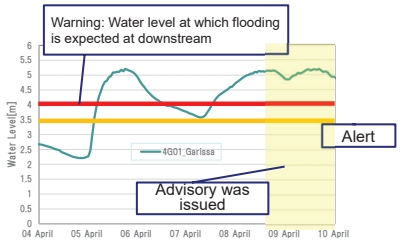
1.Outline of April 2024 Flood/ Main Flood Event

WRA issued Heavy Flood Advisory on 9th April



Water level in the Tana River at Garissa has rapidly risen above the 4m flood alarm threshold by more than 1m in the last 24 hours:
08/04/2024 4.91m at 06:00hrs
08/04/2024 5.11m at 09:00hrs
08/04/2024 5.14m at 18:00hrs
09/04/2024 4.85m at 00:00hrs
09/04/2024 4.92m at 03:00hrs

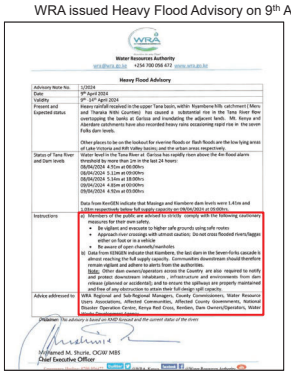
Data from KenGEN indicate that Masinga and Kiambere dam levels were 1.41m and 1.03m respectively below full supply capacity on 09/04/2024 at 05:00hrs.



Source: MIKE INFO, WRA

1.Outline of April 2024 Flood/ Main Flood Event

WRA issued Heavy Flood Advisory on 9th April



a) Members of the public are advised to strictly comply with the following cautionary measures for their own safety.
- Be vigilant and evacuate to higher safe grounds using safe routes
- Approach river crossings with utmost caution; Do not cross flooded rivers/laggas either on foot or in a vehicle
- Be aware of open channels/manholes

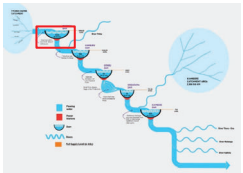
b) Data from KENGEN indicate that Kiambere, the last dam in the Seven-forks cascade is almost reaching the full supply capacity. Communities downstream should therefore remain vigilant and adhere to alerts from the authorities.
Note: Other dam owners/operators across the Country are also required to notify and protect downstream inhabitants , infrastructure and environments from dam release (planned or accidental); and to ensure the spillways are properly maintained and free of any obstruction to attain their full design spill capacity.

WRA Regional and Sub-Regional Managers, County Commissioners, Water Resource Users Associations, Affected Communities, Affected County Governments, National Disaster Operation Centre, Kenya Red Cross, KenGen, Dam Owners/Operators, Water Works Development Agency.

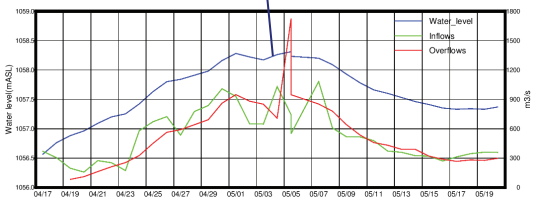
- WRA disseminated this information using Facebook, Twitter, Instagram, WhatsApp, etc.
- The Regional and Sub-basin offices play an important role in disseminating advisories from the head office.

Source: MIKE INFO, WRA

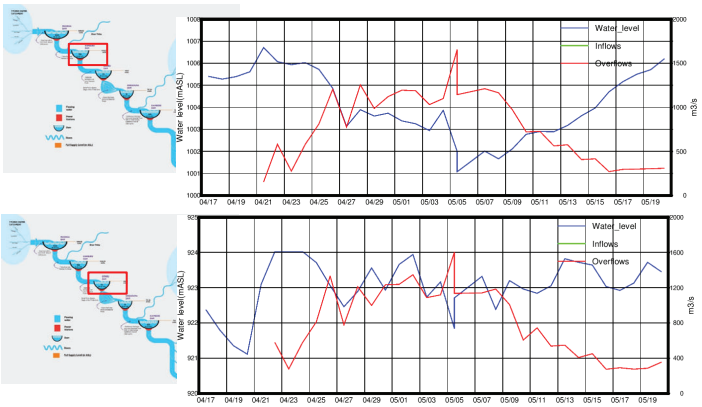
1.Outline of April 2024 Flood/ 7 Forks Dams/Masinga



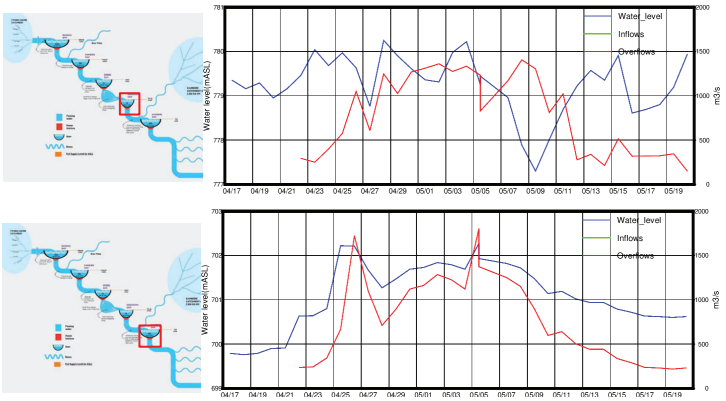
KenGen sounds warning as Masinga Dam water levels hit record high. Masinga Dam. The water level at the dam was recorded at 1,058.28 metres above sea level on May 1, 2024, against a full supply level of 1,056.50 metres.



1.Outline of April 2024 Flood/ 7 Forks Dams/Kamburu and Gitaru

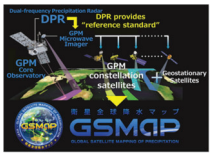


1.Outline of April 2024 Flood/ 7 Forks Dams/Kindaruma and Kiambere

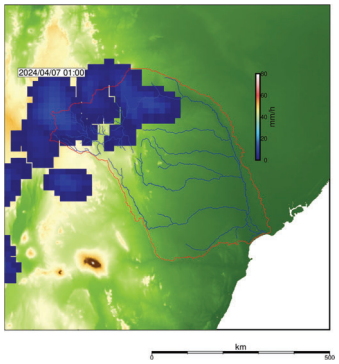


1.Outline of April 2024 Flood/ Rainfall analysis using GSMaP

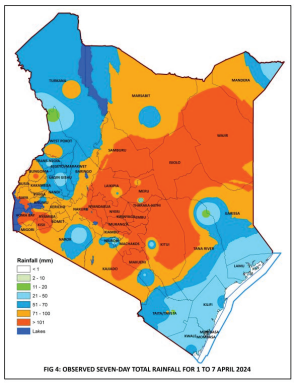
To see how the rainfall occurred, satellite-based rainfall data was visualized.



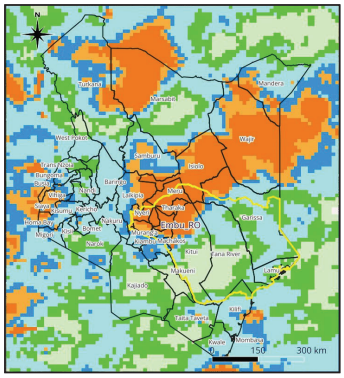
Description of rainfall data	
Variable	Rain Rate (mm/hr)
Domain	60N-60S
Grid Resolution	0.1 deg x 0.1 deg (11km x 11km)
Temporal Resolution	1 hour
Availability	1998-01-01T00:00 ～



1.Outline of April 2024 Flood/ Estimated Rainfall Distribution for 1 to 7 April 2024

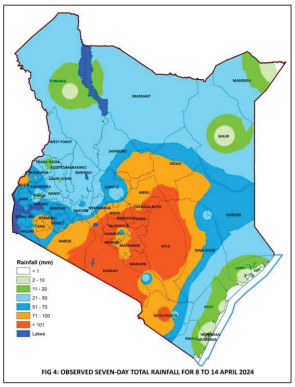


Source: KMD (spatially interpolate rain-gauge data)

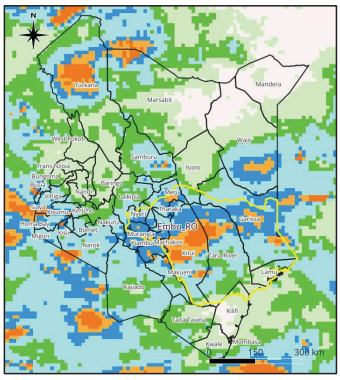


Source: JICA Expert team based on GSMaP_MVK

1.Outline of April 2024 Flood/ Estimated Rainfall Distribution for 8 to 14 April 2024

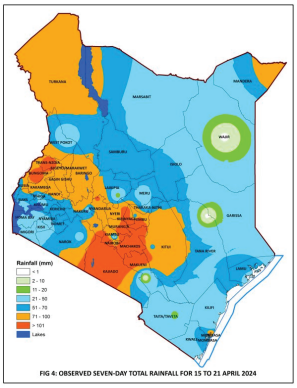


Source: KMD (spatially interpolate rain-gauge data)

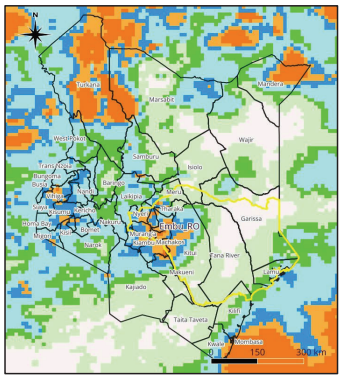


Source: JICA Expert team based on GSMaP_MVK

1.Outline of April 2024 Flood/ Estimated Rainfall Distribution for 15 to 21 April 2024

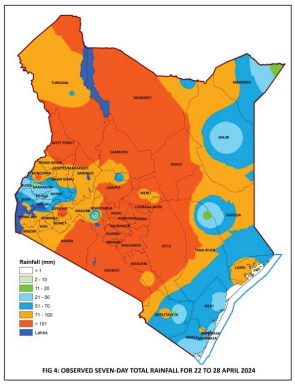


Source: KMD (spatially interpolate rain-gauge data)

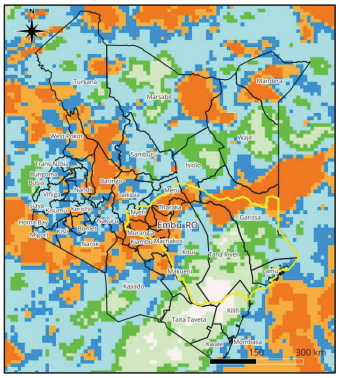


Source: JICA Expert team based on GSMaP_MVK

1.Outline of April 2024 Flood/ Estimated Rainfall Distribution for 22 to 28 April 2024

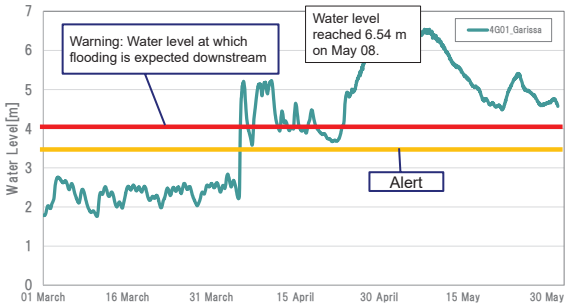


Source: KMD (spatially interpolate rain-gauge data)



Source: JICA Expert team based on GSMaP_MVK

1.Outline of April 2024 Flood/ Water level of 4G01 Garissa

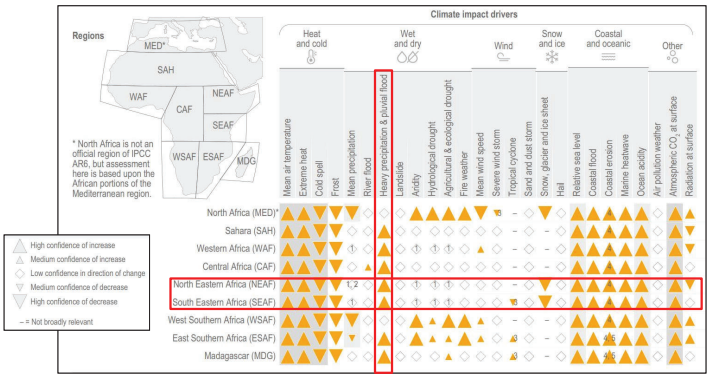


Source: MIKE INFO, WRA

2. Future Climate Risk

2.Future Climate Risk/ Projected change in climate impact drivers in Eastern Africa

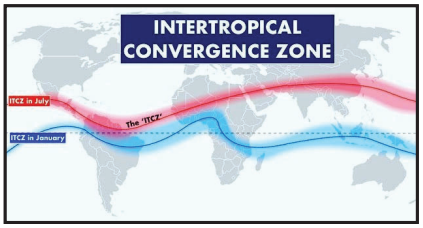
Heavy rain & pluvial flood will be increased, also need to be careful for droughts.

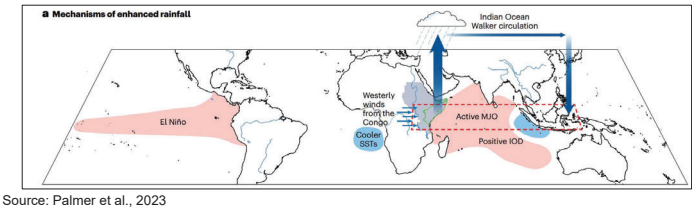


Source: IPCC AR6

2.Future Climate Risk/ Main driver of rainfall in Eastern Africa

- Migration of the ITCZ brings two rainy seasons called Long Rains(MAM) and Short Rains(OND).
- EL Nino and Positive Indian Ocean Dipole generates upward current and rainfall around Eastern Africa.

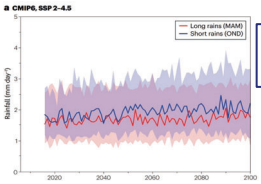




Source: Palmer et al., 2023

2.Future Climate Risk/ Future Climate of Eastern Africa

Long Rains (MAM)	No significant changes are projected for frequency and amplitude.
Short Rains(OND)	Projected to increase with global warming.
El Niño and La Niña	No significant change are projected. On the other hand, an increased occurrence of **extreme** El Niño, La Niña and Positive IOD events is projected.
Indian Ocean Dipole (IOD)	

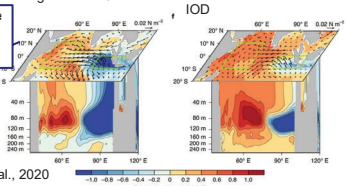


Source: Palmer et al., 2023

This state promote atmospheric convection in Eastern Africa

Strong Positive IOD

Moderate Positive IOD



Source: Palmer et al., 2020

Increasing the chance of extreme rains is associated with a **higher risk of flooding** and the potential for groundwater recharge in Eastern Africa.

3. Introduction of FEWS and RRI

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3.Introduction of FEWS and RRI / Proposed structure of future early warning system

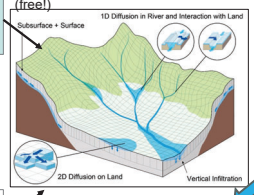
To issue Flood Advisory as soon as possible as a climate change adaptation measure, JICA expert team propose the following early warning system.

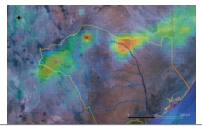
Rainfall

GSMaP (resolution: 11km x 11km)
- GSMaP_RNC(inc. forecast up to 12 hours ahead, updated every hour) etc opened by JAXA

FTP (free!)

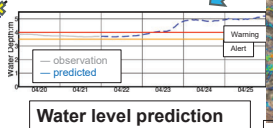
RRI(Rainfall- Runoff-Inundation) model



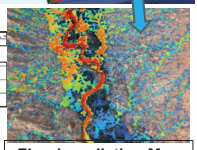


WRF:KMD's forecasted rainfall data
(10km x 10km, updated once a day)

Currently, KMD can not share raw data due to KMD's policy.



Water level prediction



Flood prediction Map

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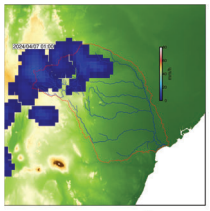
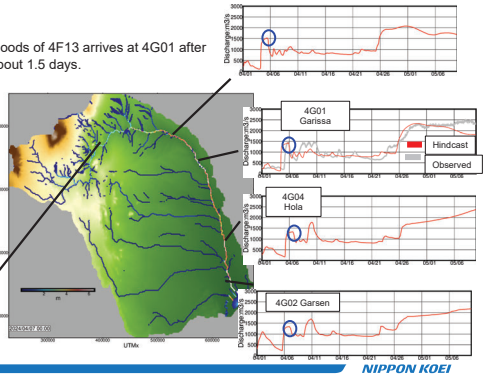
3.Introduction of FEWS and RRI / Hindcast of April 2024 flood for Entire Tana Basin Area

JICA Expert team established preliminary system as a target of April 2024 flood. GSMaP_MVK was used for rainfall data.



Rainfall Distribution of GSMaP_MVK(11km x 11km)

Floods of 4F13 arrives at 4G01 after about 1.5 days.



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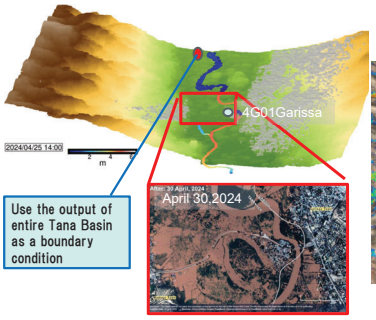
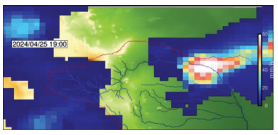
3.Introduction of FEWS and RRI / Hindcast of April 2024 flood around Garissa

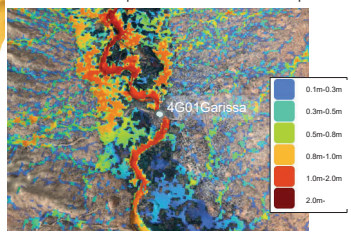
JICA expert team also developed a pilot flood inundation prediction system for the Garissa region.



Use the output of entire Tana Basin as a boundary condition



Torrential downpour hit around Garissa on April 25



Estimated maximum flood depth around 4G01 Garissa during April 2024 flood

Source: Kenya Red Cross

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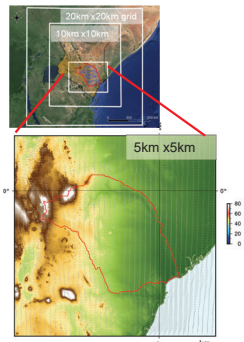
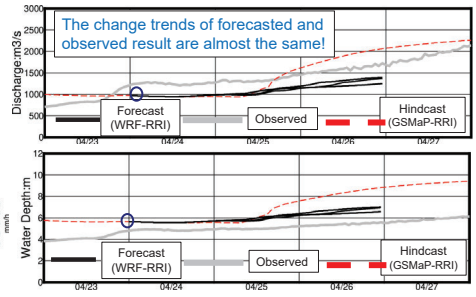
3.Introduction of FEWS and RRI / **"Forecast"** of April 2024 for Entire Tana Basin area

JICA expert team used the same numerical weather prediction model, WRF as KMD to check the performance when using forecasted rainfall.



An example of Rainfall Distribution for **WRF(5km x 5km)**



KMD's forecasted rainfall has the potential to make a significant contribution to flood damage mitigation if it can be provided.

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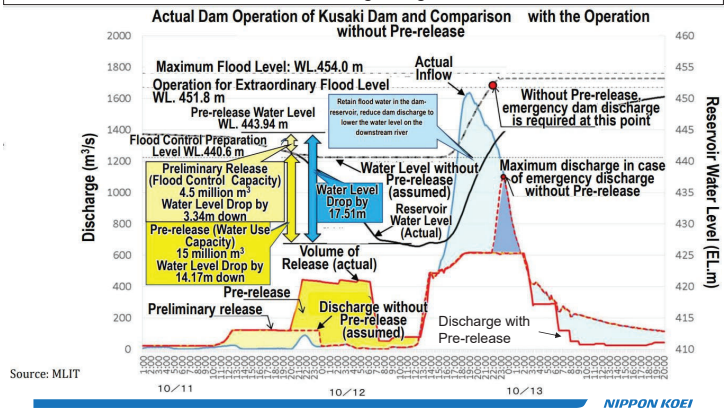
3.Introduction of FEWS and RRI / Example of pre-release when flood damage is predicted in Japan

A national system requires all dams to conduct pre-release based on rainfall forecast information, which contributes to flood damage mitigation in downstream areas.



Source: MLIT

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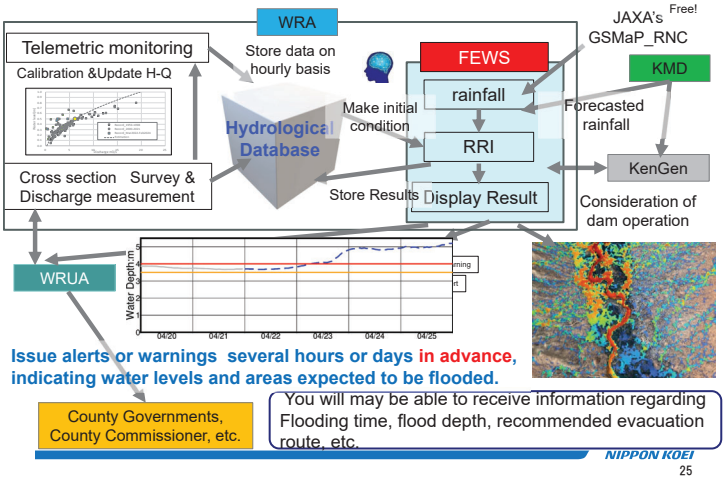
3.Introduction of FEWS and RRI /
Ideal structure of future flood damage mitigation system



Issue alerts or warnings several hours or days in advance, indicating water levels and areas expected to be flooded.

County Governments, County Commissioner, etc.

You will may be able to receive information regarding Flooding time, flood depth, recommended evacuation route, etc.

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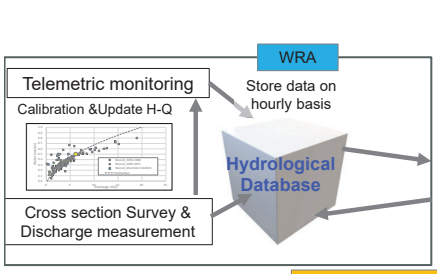
How about Drought Response?



?

WRUA

NIA

KMD

KenGen

NDMA

In charge of drought early warning system

County Governments, County Commissioner, etc.

What should we do to enhance our partnership?

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