Water Resources Development in

The Southwest Gash-Barka

By: Kesete Ghebrehiwet

The Gash-Barka region has seasonal rivers that have a flow of millions of cubic meters of water. However, relying exclusively on the seasonal water for farming and animal husbandry in an arid zone with high rate of evaporation is not sustainable. That is why the Government carried out studies on drafting micro-policies pertaining to water resources development for agriculture and domestic use since the wake of Eritrea's independence.

To ensure the continuous supply of water, it became necessary to construct off-season storage of water for use in agriculture, fish farming and conservation of the environment. Following in-depth studies and designs, r dams have been constructed in the Gash-Barka region since 2003. The three major dams constructed in the region are Fanko-Tsumu'e, Gerset and Fanko-Rawi. The major objective of the construction of the strategic dams is to promote economic and social benefits of the people and to ultimately enhance the country's overall water resource.

Segen Construction Company, which had an experience in the construction of earth-fill dams, built the dams in the Gash-Barka region. The Company first constructed Sememo Dam in the Southern region in 1996/1997. Eng. Tesfazghi

Michael, projects and infrastructure manager at Segen Construction Company, said that though Sememo was smaller in size, the experience gained in the Southern region helped in the implementation of bigger projects in the Gash-Barka region.

Eng. Dawit Berhane, Projects Hydrologist at Segen Construction Company, said that extensive hydrologic studies were carried out before the construction of the dams. The hydrological surveys carried out in the Western lowland Development Zone focus on integrated development, which determines dam construction sites for better and multifaceted benefit.

Eng. Michael Ghebrehiwet, head of Design and Infrastructural Works at Segen Construction Company, said that the designs of dams were determined by the catchment's yield and the embankment site delaminated for construction. So, the decision for the construction of earth-fill dams, as opposed to concrete dams, in the Gash-Barka region was made taking into account the fact that the catchment areas were wider in scope and suitable for the economic development of water resources. Another decisive factor was the availability of construction materials around the dam site.

The three dams — Fanko-Tsumu'e, Gerset and Fanko-Rawi – were constructed as part of the integrated water resource development projects in the Western lowlands and have catchment areas ranging from 137 to 140 sq. kms. Hydrologic studies, extensive topographic and geological surveys along with identification of materials needed for the construction of barriers were made to delineate the site and size of the dams.

Impounding as much water as possible and moving towards agro industrialization is required to raise the socio-economic status of the people living in the areas that are prone to shortage of water. The reservoir in Gherset was designed to impound water from three rivers and to minimize operational and management costs. Located 38 kms from Tesenai, in Goluj subzone, Gherset is surrounded by major river streams to the north and the south. Hence, constructing a dam in this particular location was viewed as beneficiary for the development of irrigation systems in the vast plains. Andelaib River, which is northwest of Gherset, was diverted to the main dam site through the construction of 3.2 km long canal in a bid to include about 68 sq. km. of catchment area. The future plan is to divert Goluj River to Gherset dam to enhance its catchment potential. Goluj River is enriched by water streams form Gash-Barka region and the highlands. The dam has three barriers, 1.6 km. long, forming three sections that converge into a big reservoir.

The overall plan is that since Gherset River alone is not sufficient to fill the storage capacity of the reservoir, Andelaib River was diverted to maximize water holding capacity from 45 million cubic meters in the first phase to 60 million cubic meters in the second phase. In the third phase, the plan is to divert Goluj River to the dam site to maximize the reservoir's capacity to over 150 million cubic meters so that crop failures during dry seasons can be avoided.

Fanko-Rawi, which is situated 30 kms east of Tesenai, has rich catchment area that is blessed with abundant rainfall compared to other areas in the Gash-Barka region. Streams from nearby mountains are the main sources of water for the dam. Eng. Dawit said that the topographic surveys and project designs were made based on the availability of such resources of water.

According to Eng. Tesfazghi, zoned construction methods were applied in Gherset and Fanko- Rawi while Fanko-Tsumu'e is a homogenous embankment constructed solely with solid wall of clay material. In explaining the importance of zoned construction method Eng. Tesfazghi said that in the zoned embankments, the upstream section is built with relatively impermeable material, the central core is built with impermeable material to prevent seepage

while the downstream section is built with coarser material to allow free drainage and to prevent embankment slip and other movements.

Fanko-Tsumu'e is located in Haykota sub-zone, around 30 km southeast of Tesenai, and is the first earth-fill dam to be constructed in the region by Segen Construction Company. Since Fanko-Tsumue is different in its construction, filters have been included to prevent the erosion of soil particles and to allow drainage of seepage water, Eng. Michael elaborated.

The construction of the three dams in an area marked by erratic rainfall paves a way for the introduction of off-season irrigation systems, animal husbandry and the development of agro-industries in the southwest Gash-Barka region. across watercourses were built in the delineated narrower and suitable parts of the diverted rivers. He further said that the design for dam site was determined in a way to correspond to the storage capacity and the calculated yield of the catchment, the overall size of cultivable land and the amount of water needed prior the implementation of the projects.

Fully aware of the factors that may cause the earth-fill dams to fail, precautions were taken in planning, designing, siting and, generally, engineering and safety matters related to dams, integrated natural resource development as well as sound construction practice in a bid to extend the life of the dams and to get rid of the possible damage that may be experienced due to leakage.

The Ministries of Agriculture, Mines and Energy and the Ministry of Water, Land and Environment participated in the preliminary geological surveys to

identify deposits of minerals and to conduct soil tests in the areas allocated for dam construction.

Elaborating the strategic importance of water to Eritrea, Eng. Dawit said that considering the country's geographic location, which is characterized by the prevalence of semi-arid and arid regions, maximizing the natural resources to the best possible level is the focal point of the projects aimed at enhancing water developments.

The dams have been constructed with a view to easing the challenges of the people living in the area and to motive them to settle in one location and engage in agriculture by making maximum use of the water resources. Farmers around Gherset Dam have taken the lead in making use of the opportunities provided for them.

There was a perception that building dams in the eastern and western lowlands of Eritrea is hardly possible. The big concern was that large streams of water from highlands would inundate the embankments while sediments would shorten the dams' life. What is more, many argued that building dams in an arid region would not be effective as a large amount of water would evaporate due to the hot climate.

But emphasizing the strategic importance of building dams in the eastern and western lowlands of Eritrea, Eng. Dawit Berhane, Projects Hydrologist at Segen Construction Company, said, "Every drop of water matters to the normal livelihood of Eritreans residing in the eastern and western lowlands of the country. For them, a drop of water is the very means of their survival in such an arid zone."

Eritrea's vision of ensuring food security is realized through the development of large scale agricultural undertakings, and the western lowland has been chosen for this purpose because it is endowed with large and fertile agricultural plains. After the scoping and planning of water development projects in Gash- Barka were made suitable sites for the construction of the dams were selected.

As the capital invested in building dams needs to correspond with the envisaged output, the economic development of water resources was the main point considered before and during the construction of the dams. In this regard, Eng. Michael said: "Cautious ground works were undertaken to ensure longer life of the dams while suitable sites were identified to minimize the operational expenses as much as possible."

According to Eng. Tesfazghi Michael, projects and infrastructure manager at Segen Construction Company, Fanko- Tsumu'e was constructed in three years, 2003 to 2006, at a total cost of 333,853,000 Nakfa, Gerset dam was built in four years, 2005 to 2009, at a total cost of 590,475,000 Nakfa and Fanko-Rawi was constructed in three years, 2008 to 2011, at a total cost of 255,426,000 Nakfa.

Eng. Tesfazghi believes earth-fill dams are more suitable than concrete and masonry dams in areas that have large catchment areas. Since earth-fill dams are constructed using soil, the cost of construction is a lot lower. It is unavoidable that earth-fill dams are prone to loss of water due to leakage from fractures and that sedimentation decreases the storage capacity of the dams. Eng. Michael Ghebrehiwet, head of Design and Infrastructural Works at Segen Construction Company, said rivers have been diverted to absorb as much silt as possible before the water streams get impounded in the reservoir and check dams, terraces and drainage structures have been constructed to prevent large volumes of silt from entering the dam.

After the paper work for the construction of the dams was completed, the ground work proved to be more challenging. At times, Eng. Michael said, workers were obliged to work from ten to sixteen hours and more in the construction of the dams. The Regional administration, local communities and members of the Defense Forces participated particularly in the stone riprap works at the top section of the dams. Managers, engineers and other experts in dam construction

had to stay day and night at the work site to make sure that risks are avoided or minimized to the lowest possible level.

Sharing his views regarding the challenges encountered and the experiences gained from prior construction engagements, Eng. Tesfazghi underscored that it was an exclusive opportunity that boosts the company's confidence in implementing much bigger tasks. Such an opportunity was a turning point which enabled the company to move forward.

All development undertakings in Eritrea are done by the people and for the people, and the active participation of local communities has been crucial in completing the setout programs with efficiency and within the planned time frame. For this reason, Eng. Michael expresses his appreciation to the residents of Teseney, Haykota and Goluj sub-zones for their commitment throughout the construction period of the dams.

Segen Construction Company had gained experience in building smaller dams in the highlands before it moved to the lowland to build bigger dams. For the last 15 years, starting from the time it moved to Gherset, it has been making efforts to balance the challenges with opportunities. Eng. Dawit said the company has been adhering to the principle of "minimizing challenges and maximizing any available opportunity." For instance, the human resource capacity has been growing steadily as increased exposure to challenging tasks have been creating opportunities for honing and transferring skills of those engaged in the construction of the dams.

To overcome natural challenges such as floods during rainy seasons the company had to make temporary diversion canals. At times, Eng. Tesfazghi said, structures built to support the dam unexpectedly get inundated with abundant water streams, further extending the original volume of work.
The experiences gained by Segen Construction Company have been instrumental in moving Eritrea as a county forward, from making earth-fill dams to making concrete dams. Emphasizing its implication for Eritrea as a future regional player in construction, Eng. Dawit said, "The human resource capacity built during the construction of the dams played a crucial role in the construction

of mining projects and roads, making the company more competitive at regional level,"

Mr. Getachew Merhatsion, Director of Eritrean Mapping and Information Center, said that Fanko-Rawi, which was constructed as a supplement to Fanko-Tsumu'e, has a storage capacity of 20 million cubic meter of water. At present, 2000 to 3000 hectares of land is under cultivation using water from Fanko-Rawi while water from Fanko-Tsume, which can hold up to 14 million cubic meter of water, is being used for the cultivation of vegetables.

The construction of the dams has changed the eco-system from arid zone to green land. People no longer have to travel long distance in search of water for human and animal consumption. To optimize the utilization of the water in the dams, the engineers who were involved in the construction of the dams recommend that the leveling of farmlands needs to be done in parallel with the construction of dams to have three cultivation seasons in a year.

The expertise gained in the construction of earth-fill dams was a stepping stone for the construction of major concrete and rock-fill dams in the Gash- Barka region and in the highlands such as Kerkebet, Mslam and Logo dams and other dams under construction. "The experiences we gained and the challenges we faced have been quite helpful for better accomplishment and judicious utilization of resources, with more economic irrigation technology now in demand," Eng. Dawit said.

In his final remarks about the actions that need to be taken to ensure the sustainability of the dams, Eng. Tesfazghi said that constant inspection should be made to determine the status of the dams and to ensure that the dams are operating in a safe manner, and regular inspection of spillways needs to be done to ensure a dam is not blocked by logs or trees growing near its embankment. He emphasized that the highest plant growth that should be allowed on a dam's embankment should not be more than pasture grass to serve as protection against erosion.

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