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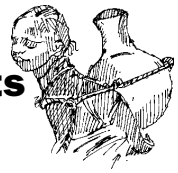
INTEGRATED DEVELOPMENT FOR WATER SUPPLY AND SANITATION



Water supply upgrading projects – their potential impacts

Adinew Adam, Ethiopia

THE ADDIS ABABA city Administration Council/Addis Ababa Water Sewerage Authority has so far executed some 13 major water supply projects. These are Kebena Mini-Dam, Kechene Mini-Dam, Series of Springs Development, Entoto Water Treatment Plant, Gafarsa-I Dam, Gafarsa-II Dam, Gafarsa-III Dam, Water-I (Legedadi Dam & Water Treatment Plant), Water-IIA (Legedadi Water Treatment Expansion & Rehabilitation of the Existing Legedadi & Gafarsa Water Treatment Plants), Water-IIB (Replacement of the Existing Legedadi Transmission & Major Lines as well as Construction of Service Water Reservoirs), Wells & Springs Development-Emergency, Akaki Town Water Supply and Dire Dam-Emergency Projects.

For the first time, the potable water supply for Addis Ababa city was initiated during the reign of Emperor Menelik in year 1895 particularly for the Palace, Patriarch & Parliament services by conveying the water through 2'' pipes. The water supply was realized by constructing mini-dam (with earth & gravel packs) along Kebena river at the slope of Entoto mountain in south. Besides these, water from this source is partially treated with lime, sand & charcoal for turbidity removal purpose. Five years later, another mini-dam (or pond) was constructed along the Kechene river and then the public water supply began in year 1901 from two water sources namely Kebena & Kechene rivers. Afterwards, various springs such as Entoto, Membere Kibur, Gojjam Ber (Meti Ber), Wochecha, Kidane Mehrete, Gullele Mesfin Harar Road, Kogole (Iyassu) & Kuskuam springs were developed in years 1911, 1926, 1927, 1927, 1937, 1937, 1938 & 1940 respectively. The Entoto water treatment plant with ozone treatment facilities having a treatment capacity of 1,500 cubic meter per day was established in year 1937 and commissioned in year 1938 to treat water coming from Kebena river & Kidane Mehrete spring(s).

Later on, the first Gafarsa dam construction with a height of 9 metres was completed in 1944 to impound 1,500,000 cubic metres of water at 18 kilometres west of the city. However, due to lack of treatment facilities and/or pipelines to convey water to the city, the source remained unused until 1952 in which the completion of 13 km pipe laying of 200 mm in diameter proceeded to the first reservoir built near Saint George Cathedral. Although the water was unclean and full of impurities during the rainy season, during the dry season it seemed clean and potable by the standards that prevailed then. Afterwards, one accelator type clarifier with six filters was built and a 400 millimetre pipeline was laid in 1954 to treat & convey 15,000 cubic metres of water per day to the City. The Gafarsa dam was raised to 15 metres of height having a storage capacity of 6,500,000 cubic metres of water and the treatment plant capacity was doubled in 1960 by constructing one additional clarifier with six filters to produce a maximum of 30,000 cubic metres of water per day. At this time many of the Springs were taken out of service because their quality was deteriorating. In 1966, the raw water storage capacity in the Gafarsa watershed (that of little Akaki river) was also increased with the construction of another earth dam north of the existing dam.

The next major phase of expansion of the water supply facilities commenced in 1970 with the commissioning of the Legedadi dam/treatment plant which was located at 33 kilometres on the big Akaki river, east of Addis Ababa City. Further development of the water supply facilities was pursued in 1986 under Water Supply Stage II Project and treatment capacity of the Legedadi Plant was upgraded from 50,000 to 150,000 cubic metres of water per day. Along these, the Dire Dam Project is completed to avail additional 42,000 cubic metres of water per day for Legedadi Plant. Meanwhile, there are some supplementary sources for water supply of Addis Ababa city from ground water points situated at different parts of the City (13 Wells & 9 Springs with a total capacity of about 13,000 cubic meter of water per day).

The Addis Ababa Water & Sewerage Authority (AAWSA) is planning to have more water sources in the coming 20 years to produce a total of about 813,500 cubic metres of water per day. Out of this, the ground water in Akaki well field is expected to produce 125,000 cubic metres of water per day while the surface water from Sibilu and Gerbi dams could have a supply of 611,500 and 77,000 cubic metres of water per day respectively.

Actual and potential positive impacts

Some of actual & potential positive impacts of water supply upgrading projects at their different stages (Planning, Construction & Operation) are:-

- Job opportunities for skilled & unskilled labor;
- Training opportunities, knowledge transfer & promotion for AAWSA employees;
- Domestic & foreign business opportunities;
- Increased water supply for domestic, commercial, industrial, institutional and public use;
- Increased income generation for AAWSA to cover its costs;

- Improved sanitation;
- Improved health conditions (environmental & human healths);
- More industrial production;
- More construction (infrastructures, houses and buildings);
- Fish resource development in raw water reservoirs;
- Increased rainfall in the surrounding areas of the raw water reservoirs; &
- Conditioned temperature in the surrounding areas of the raw water reservoirs.

Actual and potential negative impacts

Some of actual & potential negative impacts of water supply upgrading projects at their different stages (Planning, Construction & Operation) are:-

- Psychological impact (disturbance of people along the project areas);
- Loss of land;
- Loss of different plants at homesteads;
- Damage on natural vegetation along the project areas;
- Air pollution;
- Soil pollution due to soil erosion, residues of water treatment chemicals, spill of fuel & oil;
- Noise pollution;
- Water pollution;
- Damage on houses and Infrastructures (including roads, telephone lines, power lines and water lines);
- Accidents/Safety hazards (from motors, machineries, constructed structures, chlorine gas, explosions, fire, drowning, electric shock, acid burns, poisons, etc.);
- High capital, maintenance & operational costs;
- Work complexity;
- Increment of unaccounted for water (Increased leakage);
- Additional wastewater and/or sludge load;
- Resistance of AAWSA employees to changes that the new methods & technologies will bring about and/or adaptation problem;
- Damage of archaeological Sites;
- Loss of benthic species such as predatory beetles, damselflies, collector-gatherer chironomini, and other benthic groups associated with vegetation & muddy banks;
- Loss of vertebrates dependent on Benthos for food such as frogs, fish and aquatic birds;
- Change in biodiversity due to habitat & food web changes;
- Flooding of upstream & downstream areas due to filling of raw water reservoirs and/or induced seismicity at dams; &
- Land sliding/ subsidence & displacement of rocks & soil structures due to an induced seismicity at dams, tunnel along Entoto mountain ridge & over-abstraction of ground water from Akaki well field.

Mitigative measures for actual and potential negative impacts

Various mitigative measures are proposed to minimize and/ or to alleviate the actual & potential negative impacts of the water supply upgrading projects. Accordingly, the details are as follows:

Psychological Impacts(Disturbance of people along the project areas):

- Carry-out consultation process;
- Create awareness about the importance of the projects at local, regional & national levels.
  However, there exists some residual psychological impact of displaced people.

Loss of land:

- Find land for resettlement;
- Give adequate/reasonable financial compensation;
- Implement the resettlement program and monitor the effects; and
- Promote modern agricultural inputs.
  Loss of land such as farm lands, grazing lands, gardens, plantations, and residential areas is a must.

Loss of different plants at homesteads/ damage on natural vegetation:

- Give adequate/reasonable financial compensation;
- Avoid emission of air pollutants;
- Apply reforestation/plantation programs; &
- Carefully handle wastewater and/or sludge from the water treatment plants.
  However, damage of natural vegetation along access roads, water treatment plants, reservoirs & pumping stations is unavoidable.

Air pollution:

- Use vehicles, machineries and equipments with good ignition systems and fuels with very less Nitrogen and Sulphur contents (if possible free from them); and
- Apply preference of construction materials.

Soil pollution:

- Backfilling the dug/ excavated soil as per its normal sequence of structure or layer & do compaction;
- Construct retaining walls along gullies & loose soil structures;
- Cover sloppy areas & bare lands with vegetation along the construction sites, dam embankments, raw water reservoirs, water treatment plants & transmission line routes;
- Take precaution not to spill fuel, oil & chemicals on soil; and
- Treat & recover water treatment chemicals from sludge before discharging and/or use the sludge cakes for landfill at a confined area.
  However, there may be water logging and soil erosion around the raw water reservoir areas as well as some residues of water treatment chemicals (escaping from the water treatment plant).

Noise pollution:
- Use vehicles, pumps, machineries and equipments with less noise and/or with good ignition system; &
- Avoid blasting of rocks or minimize noise associated with blasting.

Water pollution:
- Apply preference in construction materials;
- Make sealing to constructed structures in order to avoid clean water, ground water and surface water contaminations;
- Construct suspended bridges made of metal anchors with a steel reinforced concrete pillars along rivers to support the water pipes;
- Provide enough spaces between the crossings/parallel to the sewer lines and water transmission lines;
- For the ground water, construct a reasonable size of radial cement grouting (some depth of 10 to 25 meters), put casings through out the borehole & fix screens (Johnson Screens) at variable depths and fence the surrounding of the borehole at a reasonable radius (about 20 meters radius);
- Treat wastewater/sludge from the water treatment plants; vii) Upgrade waste water disposal system along upgraded water supply system; viii) For the existing polluted water sources run bathymetric survey & catchment master plan studies to overcome the problem; and
- Apply regular monitoring program.

Damage on houses and other infrastructures:
- Give adequate/reasonable financial compensation; and
- Apply reconstruction programs.
  However, damage of houses which in turn causes displacement of people is inevitable.

Accidents/Safety Hazards:
- Take precautions such as displaying road/traffic signs, put labels, etc.);
- Maintain, repair & overhaul vehicles, machineries and equipments;
- Construct, maintain & repair roads;
- Use protective/safety devices;
- Fix gas detectors in working areas; and
- Avail first aid kits.

High capital, maintenance and operational costs:
- Find fund from local & international funding agencies;
- Use skilled man power at reasonable cost;
- Use cost effective/selective construction materials;
- Plan regular maintenance programs;
- Cut-off unnecessary and/or luxurious operational expenses;
- Train technical staff on regular basis;
- Apply dynamic & streamlined institutional structures for effectiveness, efficiency & productivity.

Work complexity:
- Train or give orientation to employees who are going to carry-out the respective tasks.

Increment of unaccounted for water (increased leakage):
- Lay new pipes & expand the existing distribution network;
- Apply maintenance program;
- Replace old pipes by new ones; and
- Reinforce the leakage control & monitor the overall condition.

Additional wastewater and/or sludge load:
- Have additional sanitation facilities or wastewater/sludge collection & storage facilities;
- Have additional wastewater/sludge collection & transportation facilities; and
- wastewater/sludge treatment facilities.

Resistance of AAWSA employees to changes that the new methods & technologies will bring about and/or adaptation problem:
- Create awareness for AAWSA employees on how the new methods & technologies make the work faster, more productive & life easier.

Damage of archaeological sites:
- Run detail study by having sample excavations;
- Rescue and/or recover the archaeological sites, if possible;
- Make access and preserve the archaeological sites (as terrestrial and/or aquatic).

Loss of benthic species (invertebrates and vertebrates) associated with vegetation and muddy banks and change in biodiversity along and downstream of the raw water reservoirs:
- As preventive measure allow a reasonable amount of water for downstream of the dams on continuous basis;
- Control phytoplanktonic and zooplanktonic activities; and
- Apply monitoring program.
  However, loss of some benthic species (invertebrates & vertebrates) dependent on benthos for food and slight change in biodiversity in & downstream of the raw water reservoirs is inevitable.

Flooding of the upstream and downstream areas due to filling of raw water reservoirs and/or induced seismicity at the dams:
- Put buffer zones with a reasonable sizes in upstream & downstream areas of the dams (especially around the raw water reservoirs & along the river banks in downstream areas);
- Use filter media (sand & gravel) with reasonable thickness in dam bodies that allow safe release of water to downstream areas;
- Do proper compaction on filling the materials of the dam bodies;
- Give reasonable thickness for the dam bodies with gentle slopes;
- Fix seismometers in the dam areas before constructing the dams and/or filling the dams with water and then continue the monitoring program up to long time in the operation stage for follow-up of the levels of induced

seismicity in reference to the background seismicity levels.

Land sliding/subsidence and displacement of rocks and soil structures due to an induced Seismicity:

- Do proper compaction on filling the materials of the dam bodies;
- Give reasonable thickness for the dam bodies with gentle slopes;
- Support the rock & soil structures surrounding the tunnel with rockbolts, steelsets, spiling and/or shotcrete;
- Avoid over-abstraction of ground water by maintaining safe yield conditions and apply monitoring program for the aquifer system (including level of the water table, flow direction, recharge & discharge conditions).

References

Akaki water Supply Project Feasibility Study, Volume 1: Main Report (TAHAL Consulting Engineers Ltd in association with Shawel Consult International, May 1992, Addis Ababa).

A study of Seasonal variation of Phytoplankton in relation to Water Quality in Legedadi Reservoir (Melaku Mesfin and Amha Belay, International Journal of Ecology and Environmental Science, No. 15, page 1-16, 1989).

Environmental Impact Assessment for Akaki-Addis Ababa Transmission Line Route Selection (Adinew Adam, September 1995, Addis Ababa).

Public Water Supply Demand & Resource Management Problems in Urban Ethiopia: The Case of Addis Ababa City (Mieraf Shewaye & Adinew Adam, March 1998, Addis Ababa).

The study on the Problem Analysis of Means to Control Water Quality Deterioration of Legedadi Reservoir, Final Report, Volume 1: Main Report (Soil and Water Ltd with Sub-Consultants: Devecon Oy and Metaferia Consulting Engineers PLC, October 1994, Addis Ababa).

The Water Distribution Network Manual (Shawel Consult, November 1994, Addis Ababa).

Water Quality and Its Challenges in Addis Ababa City (Adinew Adam & Nuri Mohammed, August 1998, Addis Ababa).

Water Supply and Sewerage Feasibility studies of Addis Ababa Municipality, Volume III: Special Reports to International Bank for Reconstruction and Development (BCEOM, October 1970, Addis Ababa).

Data & Information from AAWSA Records.

ADINEW ADAM, Ethiopia.