Mekelle University

Ethiopian Educational Network to Support Agricultural Transformation (EENSAT)

Field Report to the field visit to Upper Tekeze

12-14 February, 2018

Participants

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Field Report By:
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Introduction

Mekelle University, is implementing the Project on Ethiopian Educational Network to Support Agricultural Transformation (EENSAT) in collaboration with Addis Ababa University, Bahr Dar University from Ethiopia, and ITC (University of Twente, the Netherlands). EENSAT project is an innovative capacity development project to strengthen the use of geo-data for agriculture and water to enhance food security and socio-economic development in Ethiopia. In line with the Ethiopian Growth and Transformation Plan II (GTP II), from the top priorities of the Ethiopian Higher Education; food security, water resources, weather change and land administration are the major objectives of the project.

The mission of this field report is to present areas visited during 12-14 February, 2018 in the Upper Tekeze Basin, and also to present some of the points and discussions made during the excursion. The stop points are presented in the following Map.

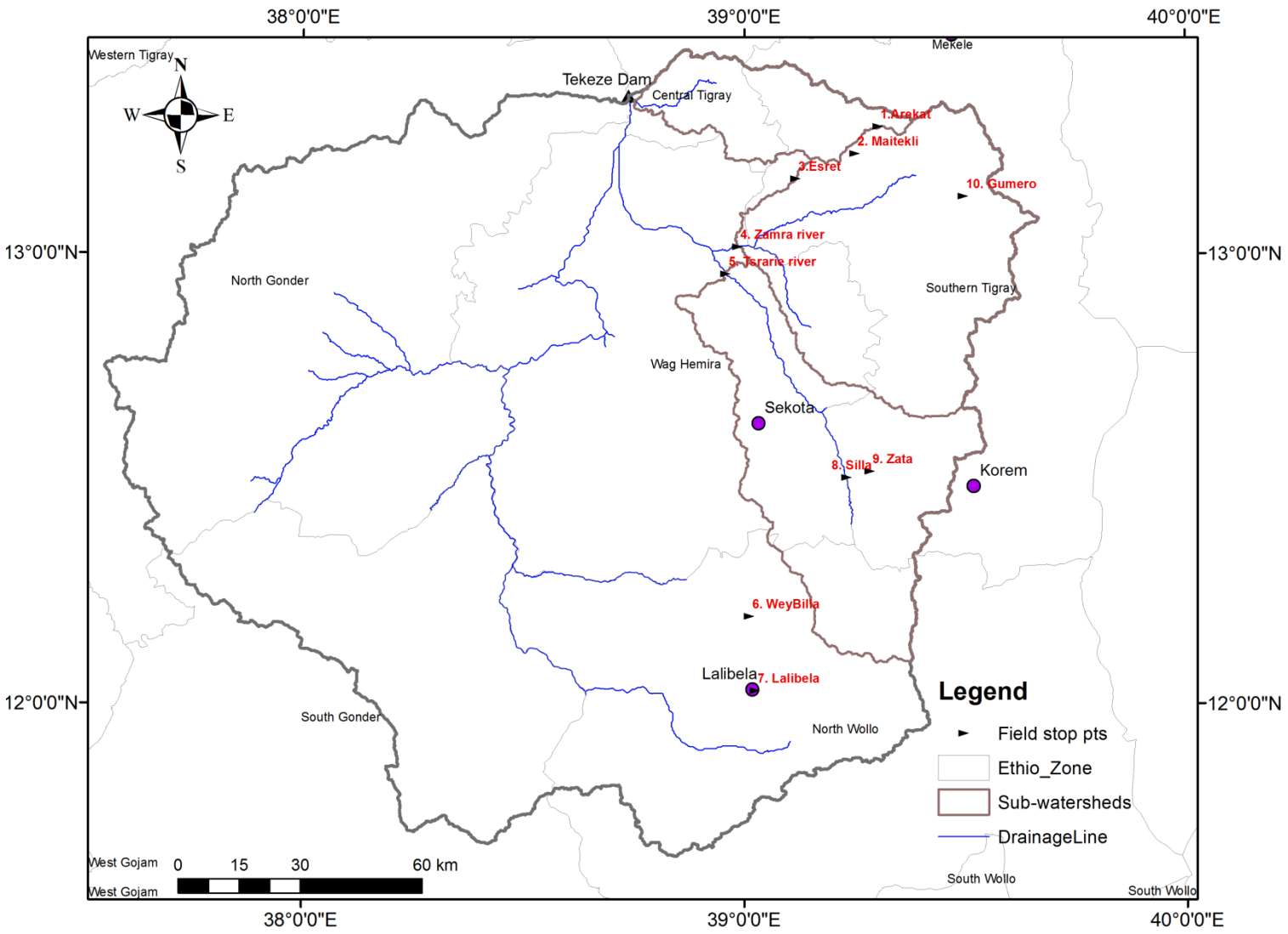

Fig 1. Field excursion in Upper Tekeze

The objectives of the field trip were:

- To expose the EENSAT PhD candidates to the EENSAT study sites,
- To give the PhD candidates a chance to discuss about their proposals with their local promoters and supervisors. Thus, to enable them to refine their PhD proposals based on the comments forwarded form the team and inputs from field observations,
- To observe and characterize the basin in relation to geology, geomorphology, soils, water and vegetation resources,
- Identify sediment source areas and types of geomorphic processes leading to sediment generation,
- To visit river gauging stations established by the Ministry of Water, Irrigation and Energy

Day One: 12 February, 2018

Visit to Zamra, AreQuet and Tsirare River (tributary from upper Tekeze) from Mekelle through Dengolat, upper head of Arequat, Samre, Yechila, Finerwa, Abergele, Zamra River and then Tsirare River. During the excursion several stops were made on the way and these will be presented as follows.

Stop 1: Meila and Haiba dams at headwater of Arequa River

Specific name of the area: Goda-Gudi

Geographical Location: 532794E and 1468374N (UTM)

In 1994-95 Meila, Haiba and other micro dams were constructed for water harvesting and irrigation development in Tigray. However, they are found highly vulnerable to siltation and seepage in response to excessing soil erosion and sediment export and leaky foundations. Some of these dams are cascading dams and are in the same catchment. It was discussed that the water quality of the two dams clearly demonstrate huge difference in terms of sediment load (turbidity) the first dam (Meila) has high sediment concentration compared to Haiba dam probably due to steep and rugged topography and also erodible soils of the dam catchment derived from Basalt. This dam also traps sediment which would otherwise transported to the Haiba dam in the downstream. Dams that trap sediment can also be used for measuring soil erosion with implication of lose of storage capacity and lose of intended use for irrigation development or hydropower generation. It was also presented that to assess the sediment yield in the reservoirs Bathymetric survey using Echo-sounder was conducted in 2016 by one MSc student at I-GEOS.

Such survey and analysis can also be used to estimate sediment yield during reservoir survey intervals depending on the hydrological conditions of a reservoir.

Figure 2: Haiba dams at the headwater catchment of Arequa River.

The participants also mentioned that the watershed can be characterized as:

1. The geomorphology of the catchments is Amba Ardom sand stone on the top following by Agulae shell on the middle, Colluvial deposit at the bottom and alluvial deposit at the farm land,
2. The LU is dominantly cultivated land and new emerging exclosures with degraded vegetation (only Eucalyptus and *Acacia Albida* are found),
3. The groundwater formation is more or less perched aquifer with shallow water table,
4. The soil is Vertisol with high organic matter,
5. Hydro-climatologically; rainfall of around 750 mm per year and the watershed is tributary to Arequat river with two new runoff stations,

6. Research: it is partly studied through PhD researches (Dr. Daniel-Haiba Dam)-on reservoir water balance and morphometric properties of dams and the catchment and MSc students -on the catchment characteristics.

Stop 2: Recent landslide on hill slope and Soil and water conservation works by the community

Specific name of the area: Mai Tekli

Geographical Location: 527094E and 1461691N (UTM)

Land slide is common in areas where there is marl and shale formation. These geological formations usually weather into clay material acting as a '*brown-sop'* inducing landslide. Landslide can also be induced due to soil and water conservation interventions by increasing infiltration and increased hydrostatic pressure particularly in exclosures. The area is vegetated and there is no large catchment area above the landslide area (see figure 3) and therefore, the reason for such landslide cannot be different from those reasons mentioned above. Massive conservation with drip irrigation from river and agroforestry is observed in this area. As can be seen in Figure 3 (Left) two parallel recent landslides are observed. These landslides have caused damage to the seedlings planted at the foot slope of the area while supplying sediment to the river.

Figure 3: Hillslope without (left) and with (Right) land rehabilitation in the form of Soil and Water Conservation.

Stop 3: Geology, Geomorphology, land use and cropping system

Specific name of the area: Esret

Geographic Location: 512540 E and 1455509 N

Shift in geological formation is common as one travel from the highlands of Mekelle area to the lowlands. There is a shift from sandstone-limestone formation to Precambrian complex, and metamorphosed sandstone and limestone formations as well as slates. We started from Mekelle area: typical highland characterized by Mekelle outlier in terms of geological formation i.e. series of alternating sandstone and limestone layering with tertiary basalt on the top of Amba Aradom formation. We moved to down from Samre reducing the altitude as a result the geology, natural vegetation and cropping system shift to a large extent. Cropping system is mainly dominated by barley, wheat and *teff* based system. The geological formation shifted from Amba Ardom sandstone to Precambrian formation composed on slates and conglomerates. The natural vegetation is dominated by acacia species as the so called Tiger skin vegetation (Figure 4). The natural vegetation is shifted from olea and Juniprous dominated highlands to Acceia dominated midlands. The area indicates that there was high erosion. This area is the most eroded area and livestock is dominant.

Figure 4: Tiger-spot vegetation in the lowland areas with the hills devoid of vegetation cover and highly affected by rill erosion.

Stop 4: Zamra River Discharge measurement stations

Specific name of the area: Zamra runoff (river discharge) gauging station

Geographical Location: 498293E and 1438753N (UTM)

Continuous water stage measuring sensor is installed at the bridges of the Zamra (Figure 5). The instrument measures the height between the instrument and the top surface of the water. The depth of the stage is calculated from the river bed. The river bed is assumed to be stable or changes very slowly. Monitoring of sediment concentration is also made by collecting depth integrated runoff and sediment sample at different points along the river cross-section.

The following gaps were forwarded during this stop:

- Extreme floods measurement is very challenging and need focus,
- Sediment measurement is manually and challenging during flush floods,
- Any gauging station to be installed should be done in communication with MoWRI for sustainability,
- Runoff response of these types of geological formation not understood well,
- Water abstraction by opportunistic irrigators along the river bank and its impact on the livelihood, food security and water balance not known,
- Elements at risk and how the opportunities in this river can integrate with water resources are not identified.

Figure 5: Sensor installed at the bridge of River Zamra for monitoring of depth of the flow (stage).

Stop 4: Tsirarie River Discharge measurement stations

Specific name of the area: Tsirarie runoff (river discharge) gauging station

Geographical Location: 495393 E and 1432165 N

Similar type of instrumentation is also installed at the Bridge of Tsirarie River. Field observations and discussions for the day were completed at Tsirarie River. Around the gauging station: *teff* and sesame are the dominante cultivated crops. The rainy season is mainly formulate June- August as "*Kiremt"* and from March to May as "*Belg"*. The participants and a local farmer indicted that there are abstraction and transmission losses through the river watercourses. In this stop, the rainfall patter, measuring of extreme events, the runoff and sediment yield versus volcanic geological formations were mentioned as key research gaps. EENSAT project should also work in collaboration with other projects in the University and the Ministry of Water, Irrigation and Energy to get access to the data available for the project works.

Figure 6: Sensor installed at the bridge of River Zamra for monitoring of depth of the flow (stage).

Day two: 13 February, 2018

This excursion was conducted from Sekota to Lalibela to observe the land uses, vegetation, watershed intervention and geomorphic processes at some parts of Tsirarie River and head water of the most upper part of Tekeze basin.

Stop one: Geology, vegetation

Specific name of the area: Wey Billa

Geographical Location: 12^{o}12’12’’N and 39^{o}00’04’’E

The landscape is highly mountainous with volcanic basalt dominated. The vegetation is increasing in areas where we go from Sekota to Lalibela. Degradation is high with parched/ small cultivated area.

Figure 6: Parched cultivated area in the landscape

Stop two: Lalibela

In Lalibal we stayed for almost one afternoon and a night and discussed on the progress of the field excursion. During the evening the team made a discussion on the following topics:

1. The PhD candidates were requested to present a brief summery on what they observed during their trip. The PhD candidates summarized their observations as follows
    - The research gaps such as the impact of vegetation, land use and geological process on hydrological response of the catchment, different geological formation and sediment yield, rainfall pattern, extreme event measurement and analysis,
    - Landscape characteristics different catchments,
    - Geology and geomorphological process the focus areas,
    - Socio-economic, livelihood, food and nutrition security,
    - Potential watersheds with their bio-physical characteristics for the PhD research projects,

2. The PhD candidates briefly presented their PhD concept note and the participants thoroughly discussed on the concept notes based on the observed research gaps and the EENSAT project objective. After the discussion, the participants agreed as follows :
    - The study area should be in gauged catchments,
    - Mewcha's PhD research proposal should include the agricultural drought analysis and the ungauged section should be omitted not to be ambitious,
    - Both (Alem's and Mewcha's) PhD research topics should not be overlapped though they are different in time scale
    - The research proposals should be refined based on the field observation on physical characteristics of watersheds and EENSAT project objective perspective.

Day three: 14 February, 201

The trip on 14 February 2018 was planned from Lalibela through Sekota to Korem- for in-depth observation and investigation of geomorphic processes staring from the headwater of Tsirarie river catchment to Korem through Mai-Mesno and Mai-Nebri. On the way three stops were made to show the different land management practices and also geomorphic processes.

Stop 1: observation on Geology at the headwater of Tsirarie Bridge

Specific name of the area: Silla
Geographical Location: 525095E and 1382117N (UTM)
Shift in geological formation is common as one travel from the highlands of Mekelle area to the lowlands. There is a shift from sandstone-limestone formation to Precambrian complex, and metamorphosed sandstone and limestone formations as well as slates. Basaltic geomorphology with long Dike crossing the river was observed (Figure 7). A potential place for establishing hydro- metrological station was observed at the bridge in the border between Tigray and Amhara regional states. The place was at Silla with established guard station where it could be safe for runoff gauging stations. The guard in the bridge said that there are wild animals like lion, tiger, snake, monkey around this site.


Figure 7: Tsirare River Bridge and its geological formation of the lowlands

Stop two: Observation of hillside development

Specific name of the area: Zata

Location: 530825E and 1383603N

Tigray is characterized as mountainous region with rugged topography and only 19% of the region is suitable for agricultural development. The regional government in collaboration with non-governmental organizations started hillside development mainly using intensive bench terrace and irrigation (Figure 8). Where the soil depth is sufficiently deep and water sources can be made available for irrigation, the hills can be developed for plantation of perennial fruit trees and irrigation and finally handed over to landless and particularly young farmers for continued and sustainable management of the hills.

Figure 8: Hillside development with bench terraces and irrigation technology for mainly perennial fruit trees.

Stop three: Headwater of the Zamra River

Specific name of the area: Maynebri

Geographical Location: 553782E and 1451199N

Gumero is located approximately 50 km South of Mekelle within the headwater catchment of Zamra River. The area is generally characterized as rugged topography, deeply incised by the Zamra River. Due to slope instability the area is highly affected by different types of geomorphic processes including land sliding. As can be evidenced from the sediment concentration in the river, the area is highly affected by erosion processes. Many dams around this area were failed because of siltation and seepage.

Figure 9: Different geological formations and water resources developments.

Old and recently reactivated landslides due to road construction are common in the headwater catchment. As this was the last stop of our trip, we discussed the following points

1. The geology at the head water are overlying as basalt rock on the top, Amba aradom, Agulae shell – limestone layers, Hintalo limestone and dikes at the outlet of the catchment
2. The catchment is highly susceptible to erosion,
3. Hydrologically, the catchment is well studied by different scientist and PhD researches on the reservoir sedimentation on series of Shilanat Dams, on hydrological characterization of Tekeze, rainfall gradient versus dam performance and CN and initial abstraction ratio, on soil and water conservation impacts on water and soil erosion and several MSc studies on geological and hydrogeological characterization,
4. There is high demand of water for irrigation however, not well managed,
5. Series of dams and diversion works are constructed throughout the watercourse down to the Zamra outlets,
6. How to quantify the impact of soil and water conservation structures on watershed responses should remain the difficult task though it equally important

7. The watershed is categorized as irrigation potential area

The trip was adjourned at 6:30 PM.

Conclusion

- This field observation help the candidates on how to integrate the catchment variations/ characteristics into hydrological models,
- Reviewing the background/ research works done so far in the watersheds should be taken as an assignment by the PhD candidates,
- Scale concept is important before actual research work,
- Such multi-disciplinary team in field observation is appreciated for experience sharing to young researchers,
- Management practices and geology consideration in hydrological responses is not well explored,
- It is unfortunate that one of the PhD candidate (Mr. Amare) couldn't participate on the field visit because of personal reasons,
- Over all, the field coordinator believed that the trip was successful and meets its objective.