Project:

Transboundary Water Management in Central Asia

Quantum Geographic Information System Training and Development of Digital Diagnostic Atlas: Intervention for Analysis and Planning Of Murgab River Basin, Turkmenistan

Final Project Report

IWMI
International
Water Management
Institute

giz
Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

Ministry of Agriculture and Water
Resources of Turkmenistan

The authors: Zafar Gafurov is a Research Officer (Remote Sensing and GIS Specialist) and Sarvarbek Eltazarov is a Regional Consultant (Remote Sensing and GIS Specialist) at the Central Asian Office of the International Water Management Institute (IWMI) in Tashkent, Uzbekistan.

Working group members

Lecturers conducted the training:

Zafar Gafurov

Sarvarbek Eltazarov

Lecturers invited for the third session of the training to provide an overview of the principles of Integrated Water Resources Management (IWRM):

Oyture Anarbekov (Integrated Water Management Specialist, International Water Management Institute [IWMI], Tashkent, Uzbekistan)

Kakhramon Djumaboev (Water Management Specialist, International Water Management Institute [IWMI], Tashkent, Uzbekistan)

Contents

Executive Summary

A training course was organized under the framework of the *Transboundary water management in Central Asia* project, which is implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in collaboration with the International Water Management Institute (IWMI) and the Ministry of Agriculture and Water Resources of Turkmenistan. IWMI was invited to conduct capacity building training and to develop a digital diagnostic atlas (DDA) for the Murgab River Basin. The main objective of the training was to familiarize participants with the innovative and modern geo-spatial tools and techniques for analyzing and monitoring water and land resources. Among the participants were representatives of governmental organizations working on water and land resources management. Quantum Geographic Information System (QGIS) was selected as the software for the training and analysis. QGIS is an open source and user-friendly software tool for the beginners in the field of GIS and remote sensing.

The training was divided into three sessions. Each session included lectures and practical sessions where participants had the opportunity to first learn the concepts of GIS and remote sensing tools and then apply these techniques in the practical hands-on exercise. During the training, participants learned (i) how to convert analogue data to digital data; (ii) pre-processing and processing of remotely sensed imagery; (iii) collection and analysis of climate data; (iv) integration of global positioning system (GPS) data; and (v) advanced methods for analyzing and monitoring water and land resources. Participants were also introduced to the concepts and principles of Integrated Water Resources Management (IWRM) and its role in natural resource management and financial management. The results of the post-training evaluation survey showed a high level of enthusiasm from the participants, practicality of the training topics to their work flow, perspectives of the tools learned and their application, etc. Moreover, participants were satisfied with the organizational and conceptual aspects of the training sessions.

Introduction

Background

The *Transboundary water management in Central Asia* project, funded by the German Federal Foreign Office, has been supporting the five Central Asian states (Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan and Tajikistan) since 2009 in strengthening regional water cooperation, application of Integrated Water Resources Management (IWRM) and river basin planning. The training was organized under the framework of this project, which is implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) in collaboration with the International Water Management Institute (IWMI) and the Ministry of Agriculture and Water Resources of Turkmenistan.

A strong and permanent element of the project is the capacity building of human resources in water-related state institutions, with a view to specifically increasing the geographic information system (GIS) capacities of staff in the ministries and related state agencies in the water resources sector.

The Quantum Geographic Information System (QGIS) training included innovative methods and techniques for analyzing and monitoring water and land resources by using GIS and remotely sensed satellite data. These methods have significant prospects in the framework of integrated water and land management.

The QGIS training comprised of theoretical and practical sessions, including discussions on the introduction of new methods and tools for mapping the land and water resources of the Murgab River Basin in Turkmenistan.

The training was divided into three sessions:

(1) Session 1: Basics of GIS and introduction to QGIS
(2) Session 2: Application of GIS in the field of water resources, drainage and land use management using QGIS
(3) Session 3: Application of GIS in the field of land degradation, the environment and the economy using QGIS

Goals and Objectives of the Project

IWMI was requested to provide training and advice (capacity development) on using advanced technologies and data management. The training consisted of two main activities:

(1) Activity 1 - Training on satellite imagery-based technologies and GIS mapping
(2) Activity 2 - Generation of Digital Basin Diagnostic Atlas

Activity 1 is divided into three sessions:

(1) Basics of GIS and Introduction to QGIS
(2) Application of GIS in the field of water resources, drainage and land use management using QGIS

(3) Application of GIS in the field of land degradation, the environment and the economy using QGIS

In Activity 2, a Russian speaking, QGIS expert was assigned by IWMI and based in the GIZ Office in Ashgabat (or in Mary) for 4 weeks to generate a Digital Diagnostic Atlas of the Murgab River Basin. This activity was essentially a continuation of the training aimed to improve the capacity of participants to develop and use a digital mapping system and a digital diagnostic atlas. The atlas was developed by combining original data from analogue sources and other datasets obtained from advanced satellite image analysis and digital GIS data.

The main aim of this activity was to increase the knowledge on IWRM, and the application of advanced technologies for water and land resources management in Turkmenistan. The main objectives were identified as follows:

(1) Increasing the knowledge of advanced computer-based methods and tools in the GIS environment and application of satellite imagery and free Google Earth programs.
(2) Generate GIS-based mapping products for the Murgab River Basin.

Activity 1: Training on Satellite Imagery-based Technologies and GIS Mapping

Meeting to Discuss Upcoming Project Activities with Representatives from GIZ and Governmental Organizations

Dates and venues: October 20-26, 2016; GIZ Office, Mary and Ashgabat, Turkmenistan

A meeting was organized in Mary Province of Turkmenistan to discuss project activities with Prof. Frank Schrader (GIZ Program Coordinator). The aim of the meeting was to discuss the technical and organizational aspects of the upcoming trainings, such as the availability of computers, venue to conduct trainings, access to internet and other necessities for the trainings. During the meeting, there was a discussion on the selection and the number of participants. In addition, it was noted that there will be a pre-training survey (see Appendix 1), as it is one of the main parts of defining a correct strategy for conducting a training for an actual audience. Training materials and data required to develop a DDA for the Murgab River Basin were discussed by GIZ and IWMI representatives.

IWMI representatives made a presentation on the data and material collected by the Institute for the training sessions and for development of a DDA for the Murgab River Basin. Furthermore, a meeting was also held with representatives of the Nature Conservation Committee and Land Cadastre Committee in Mary Province. This provided the opportunity to introduce the project and it was proposed to work in cooperation towards developing a DDA for the Murgab River Basin.

Also, the GIZ Office in Ashgabat organized an additional meeting with representatives from the Ministry of Agriculture and Water Resources (MAWR) in Turkmenistan. The aim of the meeting was to discuss training dates, venues and data required for the development of a DDA for the Murgab River Basin, as well as to plan future training sessions. During the meeting, the following schedule was prepared to conduct trainings:

Session 1: Basics of GIS and introduction to QGIS (November 14-25, 2016)

Session 2: Application of GIS in the field of water resources, drainage and land use management using QGIS (December 13-23, 2016)

Session 3: Application of GIS in the field of land degradation, the environment and the economy using QGIS (January 27, 2017-March 10, 2017)

MAWR provided a venue in Ashgabat for conducting the training, and they took responsibility for collecting and providing data for developing the DDA for the Murgab River Basin. At the end of the meeting, the pre-training survey documents for conducting future trainings were presented to MAWR representatives and discussed further.

Preparation for the Trainings

Several presentations for lectures and practical sessions were prepared, including remote sensing information and open source analogue data. The training material was prepared in Russian,

including the Russian version of the QGIS software. Data and training materials were prepared according to the project agreement.

The material prepared and information collected by IWMI included the following:

(1) 20 theoretical sessions
(2) 45 practical exercises
(3) Agenda for the sessions
(4) GIS software (QGIS, Google Earth, SASPlanet, etc.)
(5) Open source spatial data from various sources (e.g., DIVA-GIS, MapCruiser, Global Administrative Areas [GADM], etc.)
(6) 61 Landsat satellite images (Mary Province and Ashgabat City)
(7) 2 Sentinel-2 satellite images (Mary Province and Ashgabat City)
(8) 92 tiles of Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) (entire country)
(9) 7 Shuttle Radar Topography Mission (SRTM) tiles (entire country)
(10) 10 different analogue open source maps (e.g., climate map, soil map, soil salinity map, ecological systems map, etc.)

Overview of Pre-training Survey

Prior to starting the training session, a pre-training survey (Appendix 1) was carried out to assess the capacity of participants in the use of computers and GIS, and to identify the best approach to be used to train the participants in order to meet their expectations and requirements. The survey conducted showed that participants had the ability and capacity to work with computers and their proficiency level of English was good. This was important, especially since most open source GIS and remote sensing data were available in English. According to the results of the pre-training survey, all participants demonstrated a good level of computer proficiency and showed they had the capacity to use different types of software in their daily work. Some participants even possessed basic GIS and remote sensing knowledge and skills. Participants showed a high level of interest in the training, as it would provide the opportunity to learn advanced GIS and remote sensing methods and tools applied in water resources management, and to apply the knowledge gained in their daily work.

Session 1: Basics of GIS and Introduction to QGIS

Dates and venues: November 21-25, 2016; Ashgabat, Turkmenistan

Due to receiving late approval from the Government of Turkmenistan, the session 1 of the training was conducted for 1 week on an intensive basis, in order to cover all the topics and practical sessions. In total, five representatives from governmental organizations participated in the training (see Appendix 4 for the list of participants). The first training session provided an introduction to the basics of GIS and QGIS software and its working interface, and gave a good understanding of

the software to participating national experts. This training session was a stepping stone to the next sessions on using GIS tools for daily work in state agencies.

The following topics were covered during the first session (see Appendix 2 for the complete training agenda):

(1) Introduction to, and the basics of, the GIS environment and QGIS software
(2) Raster and vector data creation
(3) Editing and visualization of raster and vector data
(4) Coordinate systems and georeferencing of analogue data
(5) Working with attributes and creating a geodatabase
(6) Data acquisition from open sources
(7) Statistics for vector and raster data
(8) Analysis of shapefiles and linking statistical data into shapefiles
(9) Creating thematic maps and visualization
(10) Image acquisition from Google Earth and SASPlanet
(11) Integration between Google Earth and QGIS

A post-training survey was conducted on the organization of the training, with a view to gaining feedback from participants on the effectiveness of the training course and the lecturers, and to identify any shortcomings in the remaining two sessions (the original evaluation forms [in Russian] can be found in Appendixes 3 and 4. They have also been translated into English and summarized).

Session 2: Application of GIS in the Field of Water Resources, Drainage and Land Use Management Using QGIS

Dates and venues: December 13-23, 2016; Ashgabat, Turkmenistan

Session 2 of the training consisted of lectures and practical sessions, and was conducted on nine working days (see Appendix 6 for the list of participants). This session started with a recap of the previous session on the basics of GIS and introduction to QGIS software. The primary goal of this session was to train the participating national experts to use GIS tools for digitizing analogue data, and to work with satellite imagery for analysis, mapping and extraction of information on water and land resources through image processing and classification of satellite images. During the training period, examples and case studies were introduced, and preliminary maps of the Murgab River Basin were developed based on the available data and GIS/remote sensing information on water and land resources in the basin.

The following topics were covered during the second session (see Appendix 5 for the complete agenda):

(1) Conversion of conventional data into GIS and georeferencing
(2) Introduction to DEM and data acquisition from ASTER GDEM and SRTM
(3) Pre-processing of DEM data (tile interpretation, mosaicking tiles, clipping, extracting and data visualization)
(4) Creation of DEM for the province

(5) Derivation of slope and aspect from DEM
(6) Calculation of flow direction, flow accumulation and watershed delineation using DEM
(7) Visualization of results in 3D and 2D
(8) Introduction to remote sensing technologies: theoretical background, functionality and general structure
(9) Searching and downloading satellite data using various sources on the Internet (Landsat and Sentinel)
(10) Pre-possessing of satellite images for further analysis (atmospheric correction, mosaic images, layer stacking and clipping area of interest)
(11) Classification of satellite imagery to obtain land cover types
(12) Climate data obtained from open sources

During the second session, the participants digitized analogue maps using QGIS and developed maps. On completion of the session, participants were able to work with remote sensing data and to convert analogue data into digital format with statistical information. A post-training survey was conducted on the organization of the training (the original evaluation forms [in Russian] can be found in Appendix 6. They have been translated into English and summarized).

Session 3: Application of GIS in the Field of Land Degradation, the Environment and the Economy using QGIS

Session 3 was spread over 8 days, and consisted of lectures and practical sessions (see Appendix 8 for the list of participants). This session started with a recap of the previous session on the basics of GIS, QGIS and satellite data processing. The primary goal of the third session was to provide participating national experts with the ability to utilize GIS tools for satellite image pre-processing and processing, Normalized Difference Vegetation Index (NDVI) calculation and its interpretation, image classification based on NDVI and for conducting earth surface temperature analysis using satellite images, as well as mapping and classification of water and land resources. The participants were also shown how to use Global Positioning System (GPS) for data collection, to integrate GPS data into GIS, and to gather climate data from open sources and its interpolation.

The following topics were covered during the third session (see Appendix 7 for the complete agenda):

(1) Introduction to NDVI
(2) Identification of land cover/land-use classes and land degradation based on NDVI dynamics using Landsat images
(3) Introduction to supervised classification and accuracy assessment
(4) Assessment of surface water dynamics and environmental changes using historical remote sensing data for existing lakes in the Murgab River Basin
(5) Introduction to possibilities of obtaining Land Surface Temperature from remote sensing data
(6) GPS data collection and ways to integrate GPS data into GIS, e.g., canals, drainage canals and observation wells
(7) Importing, assessment, interpolation, analysis and visualization of GPS data
(8) Examples of remote sensing/GIS application for economical assessment using QGIS

(9) Climate data acquisition from open sources and preparation of climate data for interpolation and visualization in QGIS

(10) Concept of developing QGIS Atlas Mapbooks

(11) IWRM: Principles, and the role of GIS/remote sensing applications in IWRM for crop water requirements

(12) IWRM: Economical and financial instruments

During the last days of the session, two experts from IWMI's Central Asia Office (IWMI-CA) conducted theoretical and practical exercises on economic and financial instruments of IWRM, and the role of GIS/remote sensing applications in IWRM for crop water requirements.

At the end of the training, a post-training evaluation survey was conducted to identify the organization of the training (original evaluation form [in Russian] can be found in Appendix 8. These have been translated into English and summarized). All the participants were awarded with certificates of completion signed by IWMI and MAWR representatives (example of the certificate [in Russian] is presented in Appendix 9).

Activity 2: Generation of Digital Basin Diagnostic Atlas

Roundtable

During the period August 20-25, 2017, IWMI attended a roundtable of the *Transboundary water management in Central Asia* project and demonstrated the process of developing a Digital Diagnostic Atlas of the Murgab River Basin and its potential application in water and land resources management. The roundtable was held at the Ashgabat Office of MAWR, Turkmenistan, and representatives from MAWR and three local organizations attended the meeting. The progress made, outputs of the project and plans for future actions were presented during the meeting. The process of developing the Digital Diagnostic Atlas of the Murgab River Basin using GIS and remote sensing data and technologies was presented and explained to the participants. Moreover, the application and use of data presented in the atlas in the field of water resources management, land degradation, the environment and the economy were explained.

Digital Diagnostic Atlas: Murgab River Basin

Within the framework of activity 2 of the project, IWMI developed the geodatabase and Digital Diagnostic Atlas (DDA) of the Murgab River Basin (cover pages of the atlas can be found in Appendix 10). The geodatabase and atlas were developed in Russian and English languages. The DDA of the Murgab River Basin was created using open source software QGIS and analogue information that was already available from world-renowned organizations and used in public domain projects and scientific research certified by international agencies. The geodatabase consists of 53 spatial layers and the atlas developed has 40 pages in total.

Sources of data used for developing the atlas:

(1) International Water Management Institute (IWMI)
(2) National Aeronautics and Space Administration - Land Data Products and Services (NASA LP DAAC)
(3) International Center for Agricultural Research in the Dry Areas (ICARDA)
(4) Central Asian Countries Initiative for Land Management (CACILM)
(5) European Space Agency (ESA)
(6) World Climate Research Programme (WCRP), Coupled Model Intercomparison Project (CMIP)

The following maps are provided in the atlas:

(1) Aral Sea Basin
(2) Satellite view
(3) Location map (Mary, Turkmenistan)
(4) Administrative map
(5) Digital elevation model

(6) Slope map

(7) Slope direction map

(8) Irrigation and drainage network

(9) Watershed map

(10) Soil types

(11) Soil salinity

(12) Spatio-temporal variation of vegetation coverage over the period 2001-2004 and 2013-2016 (stable vegetation)

(13) Spatio-temporal variation of vegetation coverage over the period 2001-2004 and 2013-2016 (changes in vegetation)

(14) Land use and cover in 2015

(15) Climate zones

(16) Agro-climatic zones

(17) Potential evapotranspiration zones

(18) Annual average wind speed in 2016

(19) Annual average wind speed in 2020

(20) Annual average wind speed in 2050

(21) Annual average wind speed in 2100

(22) Annual average minimum temperature in 2016

(23) Annual average minimum temperature in 2020

(24) Annual average minimum temperature in 2050

(25) Annual average minimum temperature in 2100

(26) Annual average maximum temperature in 2016

(27) Annual average maximum temperature in 2020

(28) Annual average maximum temperature in 2050

(29) Annual average maximum temperature in 2100

(30) Annual precipitation in 2016

(31) Annual precipitation in 2020

(32) Annual precipitation in 2050

(33) Annual precipitation in 2100

An electronic version (a DVD) of the atlas is included in the back cover of the printed version of the atlas. The contents of the DVD include QGIS, ArcGIS and Google Earth compilations of the geodatabase, QGIS and SASPlanet software, and video courses in QGIS basin operations.

The DDA of the Murgab River Basin can be obtained in digital form for use by external parties with approval from the Ministry of Agriculture and Water Resources of Turkmenistan and GIZ.

The geodatabase and associated maps were created using a computer running Windows 10 Professional, QGIS 2.17 and Google Earth Engine. End users should download the package that is most appropriate for the version of QGIS software that they are using. It is important to note that QGIS is required to make use of the map package and the associated geodatabase.

In order to overlay the GIS layers on each other, a single data frame is required. In the geodatabase, the layers were projected to a common coordinate system of the World Geodetic System 1984 (WGS84).

Ceremony to Launch the Atlas

The DDA of the Murgab River Basin was presented on DVD during the 'Basin Planning Working Group' meeting held on November 15-16, 2017. The ceremony was organized by the GIZ Office in Ashgabat and held in the conference hall of the Mary Hotel. The meeting was attended by representatives from the following organizations:

- MAWR Marysuwhojalik (Mary): Water resources, irrigation, drainage
- MAWR Turkmengiprovodkhoz (Mary): Designing hydro-technical facilities
- Committee of Environmental Protection, Land Reclamation sector (Mary): Soils and land use
- Hydrometeorological survey (Ashgabat, Mary): Climate and hydrology
- State Agency on Geology (Ashgabat): Deep groundwater resources
- Ministry of Communal Services (Mary): Drinking water, and only for Mary and Bairamaly wastewater treatment
- Ministry of Public Health, Sanitarian-Epidemiological Station (Mary): Drinking water quality
- Hakimat of Mary Velayat: Overall administration support
- GIZ (Ashgabat Office)
- IWMI (Central Asia Office)

During the meeting, IWMI representatives delivered a presentation about the atlas developed and demonstrated principles of working and applying the geodatabase generated in the water sector and its potential use in different sectors such as natural resources and infrastructure management. A printed copy of the atlas with the DVD containing the geodatabase was presented to representatives of the local organizations.

The digital version of the atlas is also available online in PDF format:

(1) English version: http://centralasia.iwmi.cgiar.org/regional-content/central_asia/pdf/digital_diagnostic_atlas-murgab_river_basin.pdf
(2) Russian version: http://centralasia.iwmi.cgiar.org/regional-content/central_asia/pdf/digital_diagnostic_atlas_murgab_river_basin-russian.pdf

Post-training Evaluation Assessment

As mentioned earlier, after each session of the training, a post-training evaluation was conducted. This chapter provides a summary of all post-training surveys (detailed post-training surveys can be found in the Appendixes).

The surveys start with general questions about the name, age, contact details, organization and position of the participants. The average age of the participants was 40. The majority of participants worked in government organizations involved in water resources management. Most of them served in specialist capacities with a few also holding managerial positions.

Consequently, questions related to the importance and quality of the training were asked in the survey. A summary of some of the questions asked and the answers given is provided in the figure below.
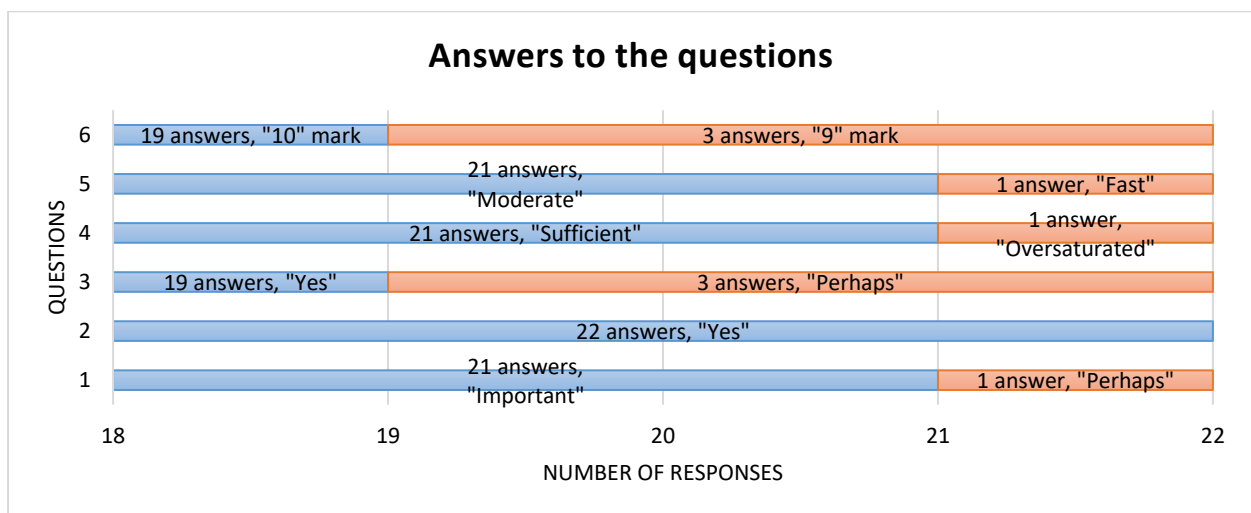
Question (1): *"Is the subject of the training important to you?"*
Answers: 21 responses indicated "Important" and only one indicated "Perhaps"

Question (2): *"Have you learned anything new? If so, please mention"*
Answers: All the responses were "Yes" and they mentioned various new skills obtained during the training, such as working in QGIS for satellite data analysis and processing, data visualization, map creation, etc.

Question (3): *"Are you able to apply this knowledge in practice?"*
Answers: 19 responses indicated "Yes" and 3 indicated "Perhaps"

Question (4): "Please rate the amount of material presented"
Answers: 21 responses indicated "Sufficient" and only one indicated "Oversaturated"

Question (5): "Evaluate the pace of the material presented"
Answers: 21 responses indicated "Moderate" and only one indicated "Fast"

Question (6): "Are you satisfied with the trainer? Mark on a scale from 0 to 10
Answers: 19 responses indicated "10" marks and 3 responses indicated "9" marks

How difficult was it to understand the material given?

2 answers, "Easy"

2 answers, "Difficult"

18 answers, "Moderate"
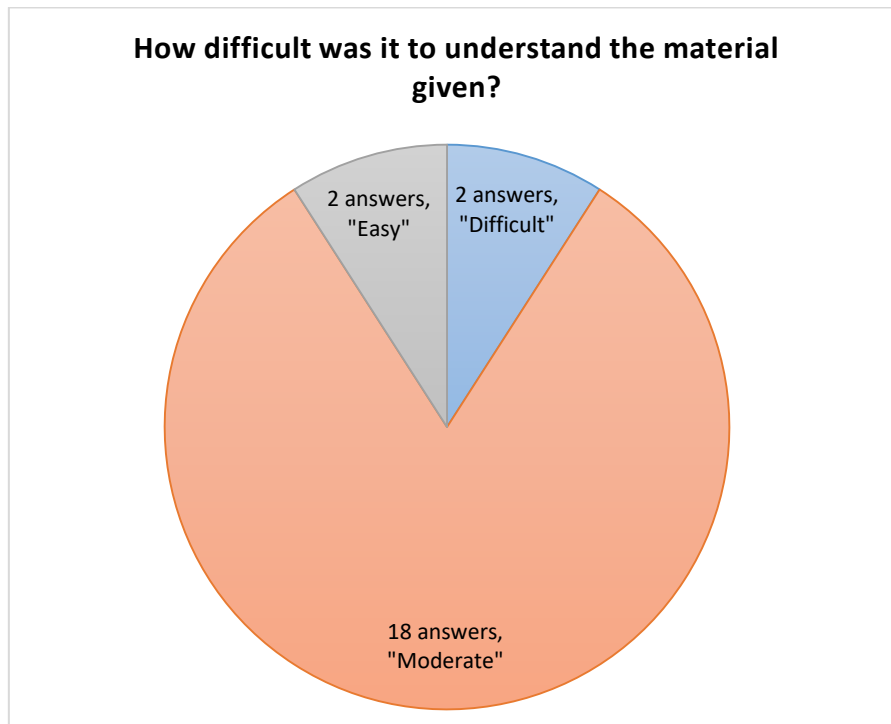
Question: "How difficult was it to understand the given material?"
Answers: 18 responses were "Moderate", 2 were "Easy" and 2 were "Difficult".

Question: "How coherent was the material given? Mark on a scale from 0 to 10
Answers: the average mark was 9.4.

Question: "How comfortable did you feel during the training? Mark on a scale from 0 to 10
Answers: the average mark received was 9.7.

In addition, for the open-ended questions about their comments on the training session conducted, participants stated that they liked the professionalism and resourcefulness of the sessions as well as the potential applicability and perspectives of the knowledge and skills gained. The participants indicated that they wished they had more time for the sessions due to the amount of material and methods covered during the short period of time. Perhaps, future training sessions could be spread over a longer period of time, so that they could have the time to apply the training skills and methods to their daily work.

Based on results of the surveys, it can be concluded that all the training sessions were conducted coherently and successfully. Furthermore, survey responses indicate that the training sessions conducted have significant importance and benefits for the participants in their daily professional lives.

Conclusion

All the activities planned under the project were completed successfully. The training sessions were attended by representatives of the government departments and they gained knowledge and skills in the application of GIS and remote sensing tools and techniques in the field of land and water resources management. It is expected that the participants will use the knowledge gained in their daily work, resulting in an improved workflow and high quality of outputs, thereby contributing to the better planning and management of water resources in the region.

The local government organizations and the donor have appreciated the project activities and outputs, as the knowledge generated and the atlas developed will make a positive contribution towards improving basin planning activities in the region, which was the main objective of the project. The donor and the local governmental organizations have shown great interest and willingness to extend the duration of the project and continue the collaboration with IWMI in the coming years.

Quantum Geographic Information System Training and Development of Digital Diagnostic Atlas: Intervention for Analysis and Planning of Murgab River Basin, Turkmenistan

Pre-training Survey

1. Name _____ Age _____

2. Organization _____

3. Type of organization _____

4. Position _____

5. Responsibilities _____

_____

6. Academic degree:
   ☐ Secondary specialized education
   ☐ Bachelor
   ☐ Master
   ☐ PhD
   ☐ Post Doc

7. Specialization _____

8. Computer proficiency:
   ☐ Beginner   ☐ Intermediate   ☐ Advanced

9. Do you use a computer to perform duties?
   ☐ Yes   ☐ No
   If "Yes", what software do you use?

_____

10. Are you familiar with GIS software (ArcGIS, Erdas, ENVI, QGis, DivaGIS, Google Earth, SASPlanet, etc.)?
    ☐ Yes   ☐ No
    If "Yes", indicate the software _____

    Your proficiency in the software:
    ☐ Beginner   ☐ Intermediate   ☐ Advanced

11. Are you familiar with remotely-sensed satellite data (Landsat, Modis, ASTER GDEM, SRTM, Sentinel, etc.)?
    ☐ Yes   ☐ No
    If "Yes", indicate which of them_____

12. English language proficiency:
    ☐ Beginner   ☐ Intermediate   ☐ Advanced

13. Why do you have a willingness to participate in this training?_____

_____

14. Expectations from the training:_____

_____

15 How development of the Digital Diagnostic Atlas of the Murgab River Basin can contribute to your workflow? _____

_____

Date «_____» _____ 2016

Appendix 2. Agenda of Session 1 of the Training.

Session 1: Basics of GIS and introduction to QGIS

Dates: November 21-25, 2016

Venue: Ministry of Agriculture and Water Resources of Turkmenistan, Ashgabat

Background

The GIS training will include innovative methods and tools for analysis and monitoring of water and land resources using GIS and remote sensing data. These methods have significant prospects in the framework of integrated water and land management. The trainings are organized under the framework of the *Transboundary water management in Central Asia* project, which is implemented by GIZ in collaboration with the International Water Management Institute (IWMI) and the Ministry of Agriculture and Water Resources of Turkmenistan.

The training is divided into three sessions:

• Session 1: Basics of GIS and introduction to QGIS
• Session 2: Application of GIS in the field of water resources, drainage and land use management using QGIS
• Session 3: Application of GIS in the field of land degradation, the environment and the economy using QGIS

Session 1 of the training is an introduction to the basics of GIS and QGIS software, which provides the national experts with a good understanding of the software. This is also a good stepping stone to the next training sessions on using GIS tools for daily work in the state agencies. During the second and third QGIS training sessions, the national experts have to be trained in the application of QGIS for the classification and mapping of water and land resources data (in the Murgab River Basin) in following working methods.

The first training will cover the following main topics:

1. Introduction to, and the basics of, the GIS environment and QGIS software
2. Working with raster and vector data
3. Coordinate systems and georeferencing of images
4. Working with attributes and creating geodatabase
5. Obtaining different open source data from various Internet sources
6. Analysis of shapefiles and linking statistical data into shapefiles
7. Creating thematic maps and visualization
8. Working with Google Earth and digitizing features on Google Earth
9. Integration of google-based data with the QGIS tool and visualization
10. Creating DEM using the QGIS tool
11. General overview of remote sensing data

Language

The training will be conducted in Russian, so fluency in Russian is compulsory for all the participants.

Resource persons for the trainings

• Zafar Gafurov (International Water Management Institute [IWMI])
• Sarvarbek Eltazarov (International Water Management Institute [IWMI])

Organized by:

**Deutsche Gesellschaft für Internationale
Zusammenarbeit (GIZ)**
Ashgabat, Turkmenistan
www.giz.org

International Water Management Institute (IWMI)
Tashkent, Uzbekistan
www.iwmi.org

**Ministry of Agriculture and Water Resources of
Turkmenistan**
Ashgabat, Turkmenistan
www.minagri.gov.tm

In cooperation with:

• Turkmengiprovodhoz
• Mary Suv Huzhalik
• Ministry of the Environment
• National Institute of Deserts, Flora and Fauna
• Hydrometeorological survey
• Committee for Land
• State Committee on Geology

Contacts:
Zafar Gafurov, IWMI (z.gafurov@cgiar.org)
Frank Schrader, GIZ (waterca@giz.de)

Participants
Participants are state employees representing state institutions working in the fields of water resources, groundwater, water supply, environment, desertification, nature conservation, climatic-hydrological observation, land resources and others.

QGIS Training - Turkmenistan - (November 21-25, 2016)					
Time	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
8:30	Registration				
9:00-11:00	**Greetings and introduction** GIZ: Venera Shayhulina **Opening training** *Dr. Frank Schraeder (GIZ)* Introduction to the training and participants	Working and visualization of vector and raster data – Practical exercise	GROUP WORK: Georeferencing of vector data	GROUP WORK: Linking of attribute table for different layers with statistical data and visual interpretation - Practical exercise	GROUP WORK: Digitizing features on Google Earth data - Practical exercise
Coffee break	10:45-11:00				
11:00-13:00	Introduction to Geographic Information Systems (GIS): Functionality and general structure	GROUP WORK: Coordinate systems and georeferencing techniques	GROUP WORK: Analysis of shapefiles and statistical outputs	GROUP WORK: Creating geodatabase and working with geodatabase – Practical exercise	GROUP WORK: Generation of DEM based on Google Earth data in QGIS, creating and visualization of 3D maps
Lunch	13:00-14:00				
14:00-16:00	Introduction to QGIS: General interface and practical exercise	GROUP WORK: Georeferencing of raster data (topographic maps, images, etc.)	GROUP WORK: Creating maps, importing and exporting data in QGIS, exercise	GROUP WORK: Open source GIS data from various Internet sources and creating thematic maps based on open source data	Overview of remote sensing data Visualizing and creating thematic maps, and discussion of the lessons learned during the first training
Coffee break	15:45-16:00				
16:00-18:00	Examples of GIS used in IWRM GIS data: Vector and raster data – Theory and practical exercise	GROUP WORK: Practice (continued)	GROUP WORK: Attribute table and working with attributes	Introduction to Google Earth/SAS Planet and downloading already georeferenced images on Google Earth and SAS Planet	Questions and answers Closing the first training session

Appendix 3. Summary of Pre-training Surveys (First Session).

	Name and age	Yanov Pashiev, 52 years old	Guych Abaev, 43 years old	Arslan Redjepov, 33 years old	Serdar Bekiev, 34 years old	Serdar Saparov, 53 years old
1						
2	Phone number and e-mail	44-83-53	44-83-23	44-83-15, rejepowarslan@mail.ru	852-27-05-24, serdar2282@mail.ru	865-55-46-38
3	Organization	Ministry of Agriculture and Water Resources in Turkmenistan	Ministry of Agriculture and Water Resources in Turkmenistan	Ministry of Agriculture and Water Resources in Turkmenistan	Production association of Mary Province water resources	Design construction institute of water resources
4	Type of organization	Ministry	Ministry	Ministry	Authority	Project Institute
5	Position	Head of Water Use Governance	Head of Water Use Department	Head of International Relations Department	Head of Water Use Department	Head of Engineering survey Department
6	Responsibilities	Water use, melioration, international water use and cooperation	Allocation of water and control	-	Ensure water-use efficiency in irrigated agriculture	
7	Education degree	Bachelors	Bachelors	Bachelors	Bachelors	Masters
8	Specialization	Mechanics of hydro-melioration	Hydro-technical engineer	Hydro-technical engineer	Hydro-technical engineer	Hydro-technical engineer
9	Computer skills	Intermediate	Advanced	Intermediate	Intermediate	Advanced
10	Do you use a computer to carry out duties? If yes, which software?	Yes, Word and Excel	Yes, Word and Excel	Yes, CorelDRAW and Photoshop	Yes, MS Office and ArcMap 10	Yes, MS Office and AutoCAD
11	Do you use the Internet to carry out duties? If yes, purpose?	Yes, data collection	-	Yes, data collection	Yes, collection and exchange of data	Yes, data collection and communication
12	Are you familiar with GIS software (ArcGIS, Erdas, ENVI, QGis, Diva-GIS, Google Earth, SASPlanet, etc.)? If yes, which software?	-	Yes, ArcGIS	Yes, ArcGIS	Yes, ArcGIS and Google Earth	Yes, Google Earth
13	Are you familiar with remote sensing data (Landsat, MODIS, ASTER GDEM, SRTM, Sentinel, etc.)? If yes, which of them?	-	No	Yes, Google Earth and Maps	Yes, ASTER and SRTM	No
	What is your level of proficiency in Russian?	Intermediate	Advanced	Advanced	Intermediate	Advanced
14	What is your level of proficiency in English?	Beginner	Beginner	Beginner	Intermediate	Intermediate
16	Why are you interested in this training?	Using during the work	Improving data analysis on water resources management	Study new methods of GIS and remote sensing, including its use in water resources management	Study advanced tools for water use and observe experience of foreign countries	Study the possibilities of GIS for my work duties
17	Expectations from the training?	Study new technologies	Study converting analogue data into digital format	Increase knowledge on innovative methods	Improve skills	Study new technologies
18	How development of the Digital Diagnostic Atlas of the Murgab River Basin can help you with your work activities?	DDA can be used in water resources management of the Murgab River Basin	DDA can be used in processing operational and scheduled data	DDA can be implemented in water resource forecasting and integrated water resources management	DDA can be the base for transformation of our water system	DDA can be used for obtaining qualified maps

Appendix 4. Summary of Post-training Surveys (First Session).

1	Name and age	Yanov Pashiev, 52 years old	Guych Abaev, 43 years old	Arslan Redjepov, 33 years old	Serdar Bekiev, 34 years old	Serdar Saparov, 53 years old
2	Organization	Ministry of Agriculture and Water Resources in Turkmenistan	Ministry of Agriculture and Water Resources in Turkmenistan	Ministry of Agriculture and Water Resources in Turkmenistan	Production association of Mary Province water resources	Design construction institute of water resources
3	Position	Head of Water Use Governance	Head of Water Use Department	Head of International Relations Department	Head of Water Use Department	Head of Engineering survey Department
4	How important is the subject of the training to you?	Important	Important	Important	Important	Important
5	Have you learned anything new? If so, please mention	Yes, about advantages and wide perspectives of software	Yes, visualization and analysis of data	Yes, data collection, calculation of line length and statistics	Yes, QGIS is more suitable in comparison to other GIS applications	Yes, technology of creating more informative maps
6	Are you able to apply this knowledge in practice?	Yes	Yes	Yes	Yes	Yes
7	Rate the intensity of the program with new information	High	Medium	Medium	High	Medium
8	How coherent was the material given? Mark on a scale from 0 to 10	10	8	5	10	10
9	Please rate the amount of material presented	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
10	How comfortable did you feel during the training? Mark on a scale from 0 to 10	10	10	8	10	10
11	How difficult was it to understand the material given?	Moderate	Moderate	Moderate	Moderate	Moderate
12	Evaluate the pace of the material presented	Moderate	Moderate	Moderate	Moderate	Moderate
13	Are you satisfied with the trainer? Mark on a scale from 0 to 10	10	10	10	10	10
14	What would you recommend to change in the training?	-	-	-	-	-
15	What are you expecting from the second training of this program?	New tools	-	Already downloaded satellite data	Continuing gradual development of the program	In-depth knowledge
16	What do you like about the training?	Potential to use in employment	Trainer provides detailed explanation	Perspectives in water use management	Training has been organized at a high level (technical and educational)	Method of providing the material and learning environment
17	General comments	-	-	-	-	Increase materials for self-study

Appendix 5. Agenda of Second Session of Training.

Session 2: Application of GIS in field of water resources, drainage and land use management using QGIS

Dates: December 13-23, 2016

Venue: Ministry of Agriculture and Water Resources of Turkmenistan, Ashgabat

Background

The importance of using advanced technologies to manage water and land resources must be highlighted. The application of GIS in water resources management is rapidly increasing, and GIS is becoming an effective tool for storing, managing and displaying spatial data in water and land resources management. This training will introduce the application of GIS in water resources management, obtaining drainage network information, and land use and land cover analyses, using conventional maps and up-to-date remote sensing information.

Session 2 of the training is a continuation of the initial introductory training on QGIS. The main aim of the second session is to provide national experts (the participants) with the knowledge required to utilize GIS tools for satellite imagery-based classification and mapping of water and land resources. The case studies and training will assist in generating initial maps of the Murgab River Basin based on both available topographic maps and GIS/remote sensing data on water and land resources in the basin.

Language

The training will be conducted in Russian, so fluency in Russian is compulsory for all the participants.

Resource persons for the trainings
- Zafar Gafurov (International Water Management Institute [IWMI])
- Sarvarbek Eltazarov (International Water Management Institute [IWMI])

Organized by

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
Ashgabat, Turkmenistan
www.giz.org

International Water Management Institute (IWMI)
Tashkent, Uzbekistan
www.iwmi.org

Ministry of Agriculture and Water Resources of Turkmenistan
Ashgabat, Turkmenistan
www.minagri.gov.tm

In cooperation with:
- Turkmengiprovodhoz
- Mary Suv Huzhalik
- Ministry of the Environment
- National Institute of Deserts, Flora and Fauna
- Hydrometeorological survey
- Committee for Land
- The State Committee on Geology

Contacts:
Zafar Gafurov, IWMI (z.gafurov@cgiar.org)
Frank Schrader, GIZ (waterca@giz.de)

Participants

Participants are state employees representing state institutions working in the fields of water resources, groundwater, water supply, environment, desertification, nature conservation, climatic-hydrological observation, land resources and others.

Time	Tuesday	Wednesday	Thursday	Friday
	QGIS Training - Turkmenistan - (December 13-23, 2016) - First week			
8:30	Registration			
09:00-11:00	Greetings and introduction *Venera Shayhulina (GIZ)* Introduction to the training and participants	GROUP WORK: Georeferencing and conversion of conventional data to GIS: - Soil map	GROUP WORK: Georeferencing and conversion of conventional data to GIS: - Rivers and main irrigation canals	Introduction to Digital Elevation Model: Capacity and data acquisition – Theoretical session GROUP WORK: Data acquisition from Shuttle Radar Topography Mission (SRTM) and ASTER GDEM
Coffee break	10:45-11:00			
11:00-13:00	GROUP WORK: Repetition of the previous studies: - Vector data visualization - Raster data visualization	GROUP WORK: Georeferencing and conversion of conventional data to GIS: - Soil salinization map	GROUP WORK: Georeferencing and conversion of conventional data to GIS: - Main drainage systems	GROUP WORK: DEM data uploading and pre-processing in QGIS - Tile interpretation - Mosaic tiles
Lunch	13:00-14:00			
14:00-15:30	GROUP WORK: Repetition of the previous studies: - Analysis and statistics of vector and raster data - Creation of shp (vector) files -	GROUP WORK: Georeferencing and conversion of conventional data to GIS: - Ecosystem map	GROUP WORK: Georeferencing and conversion of conventional data to GIS: - Climate map	GROUP WORK: DEM data uploading and pre-processing in QGIS - Methods of clipping and extracting - Data visualization
Coffee break	15:45-16:00			
16:00-17:00	GROUP WORK: Repetition of the previous studies: - Image georeferencing - Data acquisition from SAS Planet - Data georeferencing and conversion from Google Earth to QGIS	GROUP WORK: Georeferencing and conversion of conventional data to GIS: - Water resources	GROUP WORK: Georeferencing and conversion of conventional data to GIS: - Precipitation map	GROUP WORK: Processing of DEM data for watershed analysis: - Slope calculation - Aspect calculation

QGIS Training - Turkmenistan - (December 13-26, 2016) - Second week					
Time	Monday	Tuesday	Wednesday	Thursday	Friday
09:00-11:00	GROUP WORK: Processing of DEM data for watershed analysis: - Flow direction - Flow accumulation - River, canal delineation	Information on satellite data - Open source data - Commercial data	Introduction to land-use classification of satellite images – Theoretical session GROUP WORK: Unsupervised classification of land use and land cover	GROUP WORK: Uploading the GPS data into QGIS and analysis	GROUP WORK: Climate data obtained from The European Centre for Medium-Range Weather Forecasts (ECMWF)
Coffee break	10:45-11:00				
11:00-13:00	GROUP WORK: - Watershed delineation - Watershed visualization and area calculation	GROUP WORK: Satellite data acquisition from various sources on the Internet (Landsat, Sentinel and MODIS)	GROUP WORK: (Continued)	GROUP WORK: Supervised classification of satellite images and validation	GROUP WORK: Uploading climate data into QGIS and interpolation
Lunch	13:00-14:00				
14:00-15:30	GROUP WORK: - 3D visualization of DEM data - Watershed map creation	GROUP WORK: Pre-processing of satellite images for analysis: - Atmospheric correction - Mosaic images	FIELD VISIT: Collection of Global Positioning System (GPS) location: - Observation wells and characteristics - Canals and drainages	GROUP WORK: Observation wells data interpolation (groundwater level and salinity)	GROUP WORK: Post-training survey with participants
Coffee break	15:45-16:00				
15:30-17:00	Introduction to remote sensing technologies: functionality and general structure – Theoretical session	GROUP WORK: Pre-processing of satellite images for analysis: - Layer stacking and visualization of true and false colours - Clipping of interested area	FIELD VISIT: Collection of GPS location: - Crop types for supervised classification	GROUP WORK: Map creation using developed data	Questions and answers Closing the second training session

Appendix 6. Summary of Post-training Surveys (Second Session).

1	Name and age	Yanov Pashiev, 52 years old	Guych Abaev, 43 years old	Arslan Redjepov, 33 years old	Serdar Bekiev, 34 years old	Serdar Saparov, 53 years old	Khakimova, 47 years old
2	Organization	Ministry of Agriculture and Water Resources in Turkmenistan	Ministry of Agriculture and Water Resources in Turkmenistan	Ministry of Agriculture and Water Resources in Turkmenistan	Production association of Mary province water resources	Design construction institute of water resources	National institute of desert, flora and fauna
3	Position	Head of Water Use Governance	Head of Water Use Department	Head of International Relations Department	Head of Water Use Department	Head of Engineering survey Department	Research associate
4	How important is the subject of the training to you?	Important	Important	Important	Important	Important	Important
5	Have you learned anything new? If so, please mention	Yes, using GIS tools	Yes, a lot of necessary information and capacity of QGIS	Yes, satellite data and image processing	Yes, great capacities of software	Yes, high level of GIS technologies	Yes, opportunities of the software in workflow
6	Are you able to apply this knowledge in practice?	Yes	Yes	Yes	Yes	Yes	Yes
7	Rate the intensity of the program with new information	High	High	Medium	High	High	High
8	How coherent was the material given? Mark on a scale from 0 to 10	10	10	8	10	9	10
9	Please rate the amount of material presented	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
10	How comfortable did you feel during the training? Mark on a scale from 0 to 10	10	10	8	10	10	10
11	How difficult was it to understand the material given?	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
12	Evaluate the pace of the material presented	Moderate	Moderate	Moderate	Moderate	Fast	Moderate
13	Are you satisfied with the trainer? Mark on a scale from 0 to 10	10	10, experienced and qualified trainers	9	10, professionalism and resourcefulness	9	10, high professionalism of trainers
14	What would you recommend to change in the training?	-	-	-	-	-	-
15	What are you expecting from the third session of this training?	Skills	-	Creation of maps	Thematic continuation of second training	A lot of practical exercises	Introduction, study and consolidation of skills obtained
16	What do you like about the training?	Teaching methods	-	Relief assessment of area	Comprehensive approach to the training	Everything	Study new capacities of information technologies
17	General comments	Thank you for trainings	-	I wish to continue the trainings and hope that more such trainings will be organized	-	Increase of information volume	-

Appendix 7. Agenda of Third Session of Training.

Session 3: Application of GIS in the field of land degradation, the environment and the economy using QGIS

Dates: February 27, 2017 - March 9, 2017

Venue: Ministry of Agriculture and Water Economy of Turkmenistan, Ashgabat

Background

The importance of using advanced technologies to manage water and land resources must be highlighted. The application of GIS in water resources management is rapidly increasing and GIS is becoming an effective tool for storing, managing and displaying spatial data in water and land resources management. This training will introduce the application of GIS in water resources management, obtaining drainage network information, and land use and land cover analyses using conventional maps and up-to-date remote sensing information.

Session 3 of the training is a continuation of the initial introductory and second training sessions on QGIS. The primary goal of the third session is to provide national experts (the participants) with the ability to utilize PC GIS tools for satellite imagery-based classification and mapping of water and land resources. The case studies and training will generate initial maps of the Murgab River Basin based on available GIS/remote sensing data on water and land resources in the Murgab River Basin.

Language

The training will be conducted in Russian language, so fluency in Russian is compulsory for all the participants.

Resource persons for the trainings
- Zafar Gafurov (International Water Management Institute [IWMI])
- Sarvarbek Eltazarov (IWMI)
- Kakhramon Djumabaev (IWMI)
- Oyture Anarbekov (IWMI)

Organized by

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
Ashgabat, Turkmenistan
www.giz.org

International Water Management Institute (IWMI)
Tashkent, Uzbekistan
www.iwmi.org

Ministry of Agriculture and Water Resources of Turkmenistan
Ashgabat, Turkmenistan
www.minagri.gov.tm

In cooperation with:
- Turkmengiprovodhoz
- Mary Suv Huzhalik
- Ministry of the Environment
- National Institute of Deserts, Flora and Fauna
- Hydrometeorological survey
- Committee for Land
- The State Committee on Geology

Contacts:
Zafar Gafurov, IWMI (z.gafurov@cgiar.org)
Frank Schrader, GIZ (waterca@giz.de)

Participants

Participants are state employees representing state institutions working in the fields of water resources, groundwater, water supply, environment, desertification, nature conservation, climatic-hydrological observation, land resources and others.

QGIS Training - Turkmenistan - (February 27-March 9, 2017)					
Time	February 27, 2017	February 28, 2017	March 1, 2017	March 2, 2017	March 3, 2017
	Day 1	Day 2	Day 3	Day 4	Day 5
8:30	Registration				
09:00-11:00	Greetings and introduction *Frank Schrader (GIZ)* Introduction to the training and participants	Introduction to Normalized Difference Vegetation Index **(NDVI)** and identification of land cover/use and land degradation based on NDVI dynamic change	Introduction to supervised classification and accuracy assessment	Assessment of surface water dynamics and environmental changes using historical remote sensing data for existing lakes in the Murgab River Basin	Introduction to possibilities of obtaining Land Surface Temperature from remote sensing data
Coffee break	10:45-11:00				
11:00-13:00	GROUP WORK: Repetition of the previous studies: - Image mosaicking - Calculation of slope and aspect from DEM - Calculation of flow direction and accumulation	GROUP WORK: Image pre-processing: - Atmospheric correction prior to NDVI calculation (available cloud-free images)	GROUP WORK: Image preparation for classification of land cover types: - Atmospheric correction - Masking the area of interest	INDEPENDENT WORK: Image preprocessing: - Delineation of area of interest (water covered areas)	GROUP WORK: - Identification of surface emissivity - Reclassification of classes
Lunch	13:00-14:00				
14:00-15:30	GROUP WORK: Repetition of the previous studies: - Watershed analysis - Atmospheric correction	GROUP WORK: Image processing: - NDVI calculation and visualization (available cloud-free images)	GROUP WORK: Image pre-processing: - Layer stacking - Sampling of images and signature creation	INDEPENDENT WORK: - Image pre-processing: - Layer stacking - Sampling of images and signature creation	GROUP WORK: - Calculation of land surface temperature
Coffee break	15:45-16:00				
16:00-17:00	GROUP WORK: Repetition of the previous studies: - Image stacking - Unsupervised classification	GROUP WORK: Image processing: - Stacking of NDVI layers - Signature creation - Identification of crop types based on vegetation phenology	GROUP WORK: Image processing: - Applying classification - Accuracy assessment	INDEPENDENT WORK: Image processing: - Delineating water covered areas through classification - Dynamic change analysis of lakes	GROUP WORK: - Temperature map and visualization

	QGIS Training - Turkmenistan - (February 27-March 9, 2017)			
Time	March 4, 2017	March 6, 2017	March 7, 2017	March 9, 2017
	Day 6	Day 7	Day 8	Day 9
8:30	Registration			
09:00-11:00	FIELDWORK: GPS data collection and ways to integrate with GIS environment : - Canals - Drainage canals - Observation wells - Groundwater table	GROUP WORK: Examples of GIS/remote sensing application for economic assessment using QGIS	Integrated Water Resources Management (IWRM): Principles, role of GIS/remote sensing applications in IWRM for crop water requirements	Integrated Water Resources Management: Economic and financial instruments
Coffee break	10:45-11:00			
11:00-13:00	FIELDWORK: GPS data collection: - Groundwater salinity - Soil type - Soil salinity level	GROUP WORK: Climate data acquisition from open sources Preparation of climate data for interpolation and visualization	Continuation	Continuation
Lunch	13:00-14:00			
14:00-15:30	GROUP WORK: Importing GPS data, interpretation and interpolation	GROUP WORK: Creation of climate maps	Integrated Water Resources Management: Water distribution and accounting	Integrated Water Resources Management: Economic and financial instruments
Coffee break	15:45-16:00			
16:00-17:00	GROUP WORK: Analyzing and visualization of GPS data Creating maps based on GPS data	GROUP WORK: Concept of developing QGIS Atlas Mapbooks	Continuation	Conducting post-training survey Closing the training session

## Appendix 8. Summary of Post-training Surveys (Third Session).

1	Name and age	Guych Abaev, 43 years old	Arslan Redjepov, 33 years old	Serdar Bekiev, 35 years old	Serdar Saparov, 53 years old	Agamurad Madamanov	Ogultagan Nurmukhammedova, 27 years old
2	Phone number and email	44-83-23	44-83-15, rejepowarslan@mail.ru	8-65-89-32-53, serdar2282@mail.ru	+993-65-554638, serdar@mail.ru, serdar7745@gmail.com	+993-65-043577, +993-31-2444579, gate@mail.ru	+99364390639
3	Organization	Ministry of Agriculture and Water Resources in Turkmenistan	Ministry of Agriculture and Water Resources in Turkmenistan	Production association of Mary province water resources	Design construction institute of water resources	Ministry of communal resources in Turkmenistan	Association of water resource management, Balkan province, Turkmenistan
4	Position	Head of Water Use Department	Head of International Relations Department	Head of Water Use Department	Head of Engineering survey Department	Engineer network department, Chief Specialist	Water management specialist
5	How important is the subject of the training to you?	Important	Important	Important	Perhaps	Important	Important
6	Have you learned anything new? If yes, please mention	Yes, possibilities of QGIS software	Yes	Yes, broad opportunities of QGIS in our workflow	Yes, perspectives of QGIS	Yes, perspectives of QGIS and significant articles for website of organization	Yes, about QGIS software
7	Are you able to apply this knowledge in practice?	Perhaps	Yes	Yes	Yes	Yes	Perhaps
8	Rate the intensity of the program with new information:	High	Medium	High	High	High	High
9	How coherent was the given material? Mark on scale from 0 to 10:	10	8	10	10	9	10
10	Please rate the amount of presented material	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
11	How comfortable did you feel during the training? Mark on scale from 0 to 10:	10	10	10, detailed description of materials	10	10	10
12	How difficult was it to understand the given material?	Moderate	Moderate	Moderate	Moderate	Moderate	Difficult
13	Evaluate the pace of presented material	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
14	Are you satisfied with the trainer? Mark on scale from 0 to 10	10	10	10	10	10	10
15	What would you recommend to change in the training?	-	-	-	Additional card information (for each satellite and significant themes)	Everything was conducted at a high level	-
16	What do you like about the training?	-	-	High perspectives of software	Everything	Training has been successful	-
17	General comments	-	-	While process could appear additional questions, contact details should be saved	-	See you again	-

1	Name and age	Chariyar Chetiev, 30 years old	Meylis Ataev, 29 years old	Nurmuxammad Tubakov, 44 years old	Nurli Geldiev, 51 years old	Mexriban Rakhmanova, 27 years old
2	Phone number and email	44-78-82	44-78-82	+993-65-566155, muhammed210@mail.ru	+99365194843	+99363965670
3	Organization	State Committee for Environmental Protection and Land Resources, Turkmenistan	State Committee for Environmental Protection and Land Resources, Turkmenistan	State service for geological control, Turkmenistan	Association of water resource management, Balkan province, Turkmenistan	Hydromet, Turkmenistan
4	Position	Chief Specialist	Chief Specialist	Head of water cadastre department	Head of exploitation department	Engineer-hydrology
5	How important is the subject of the training to you?	Important	Important	Important	Important	Important
6	Have you learned anything new? If yes, please mention	Yes, perspectives of software	Yes	Yes, working in QGIS and importing data from GPS	Yes, introduction to GIS	Yes, about the QGIS
7	Are you able to apply this knowledge in practice?	Yes	Yes	Yes	Yes	Perhaps
8	Rate the intensity of the training with new information:	High	High	High	High	High
9	How coherent was the material given? Mark on scale from 0 to 10	10	10	10	10	10
10	Please rate the amount of presented material	Sufficient	Sufficient	Sufficient	Sufficient	Oversaturated
11	How comfortable did you feel during the training? Mark on scale from 0 to 10	10	8	10	10	9
12	How difficult was it to understand the given material?	Moderate	Easy	Moderate	Easy	Difficult
13	Evaluate the pace of presented material	Moderate	Moderate	Moderate	Moderate	Moderate
14	Are you satisfied with the trainer? Mark on scale from 0 to 10	10	9	10, training conducted in professional level	10	10, Thanks a lot to Zafar and Sarvarbek
15	What would you recommend to change in the training?	-	-	-	-	Everything okay
16	What do you like about the training?	-	-	Actions by trainers in order to deliver study material, their punctuality and professionalism	Everything	Almost every material
17	General comments	-	-	-	-	-

Appendix 9. Copy of the certificate awarded to participants (in Russian).

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International
Water Management
Institute

СЕРТИФИКАТ

выдан

АБАЕВУ ГУЙЧУ СУЛЕЙМАНОВИЧУ

ДЕЙСТВИТЕЛЬНО В ТОМ ЧТО

ПРИНЯЛ УЧАСТИЕ В СЛЕДУЮЩИХ ОБУЧАЮЩИХ ТРЕНИНГАХ

С 21 НОЯБРЯ 2016 г. ПО 25 НОЯБРЯ 2016 г.

По теме: Введение в географические информационные системы и базовое обучения Quantum GIS

С 12 ДЕКАБРЯ 2016 г. ПО 23 ДЕКАБРЯ 2016 г.

По теме: Применение ГИС в области водных ресурсов, дренаж и землепользования с использованием Quantum GIS

С 27 ФЕВРАЛЯ 2017 г. ПО 9 МАРТА 2017 г.

По теме: Применение ГИС в области деградации земель, окружающей среды и экономики с использованием Quantum GIS

ТРЕНИНГ БЫЛ ПРОВЕДЕН СО СТОРОНЫ МЕЖДУНАРОДНОГО ИНСТИТУТА УПРАВЛЕНИЯ ВОДНЫМИ РЕСУРСАМИ (ОФИС ПО ЦЕНТРАЛЬНОЙ АЗИИ) В РАМКАХ GIZ ПРОГРАММЫ «ТРАНСГРАНИЧНОЕ УПРАВЛЕНИЕ ВОДНЫМИ РЕСУРСАМИ В ЦЕНТРАЛЬНОЙ АЗИИ» В СООТРУДНИЧЕСТВЕ С МИНИСТЕРСТВОМ СЕЛЬСКОГО И ВОДНОГО ХОЗЯЙСТВА ТУРКМЕНИСТАНА.

Пащыев Янов Дурдыевич	**Зафар Гафуров**	**Сарварбек Элтазаров**
Начальник управления водопользования, Министрество сельского и водного хозяйства Туркменистана	Специалист в области Геоинформационные системы и дистанционное зондирование, Международный институт управления водными ресурсами	Специалист в области Геоинформационные системы и дистанционное зондирование, Международный институт управления водными ресурсами

Appendix 10. Cover pages of the Digital Diagnostic Atlas: Murgab River Basin.

Digital Diagnostic Atlas:
MURGAB RIVER BASIN

Zafar Gafurov and Sarvarbek Eltazarov
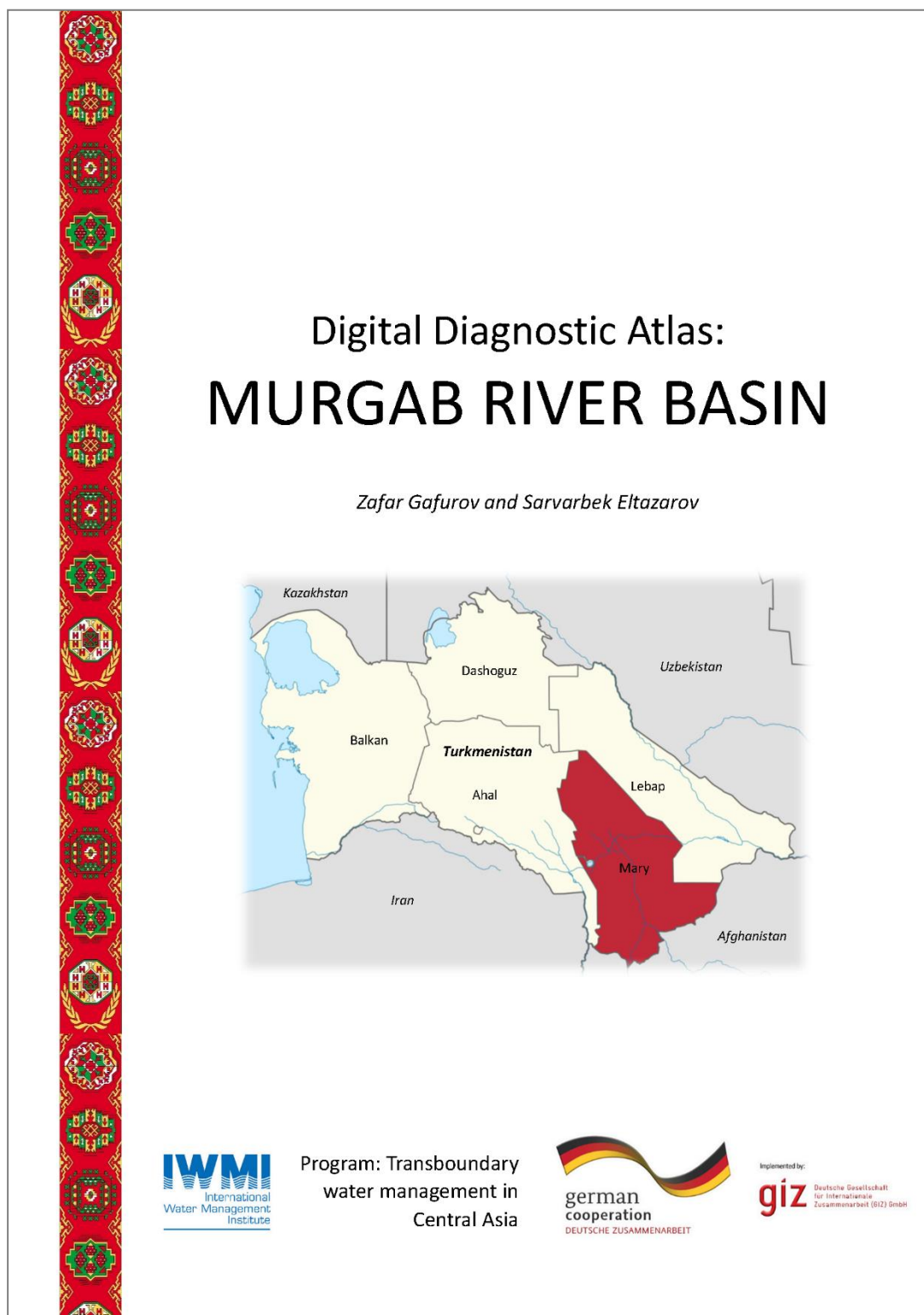
Cover page of the Digital Diagnostic Atlas: Murgab River Basin (English version)

Цифровой Диагностический Атлас
бассейна реки Мургаб

Зафар Гафуров и Сарварбек Эльтазаров

Cover page of the Digital Diagnostic Atlas: Murgab River Basin (Russian version)

Appendix 11. Photos from the Project Activities.

Theoretical session of the training at MAWR (*photo:* Sarvarbek Eltazarov).

Practical session of the training at MAWR (*photo:* Arslan Redjepov).

IWMI trainers with participants at MAWR (*photo:* Maral Nuryyeva).

Awarding of certificates to participants at MAWR (*photo:* Arslan Redjepov).

Roundtable of the *Transboundary water management in Central Asia* project at MAWR (*photo:* Maral Nuryyeva)

Ceremony to launch the Digital Diagnostic Atlas and 'Basin Planning Working Group' meeting in Mary, Turkmenistan (*photo:* Sarvarbek Eltazarov)

Launch of the Digital Diagnostic Atlas by a representative from GIZ (*photo:* Sarvarbek Eltazarov)

Participants at the ceremony to launch the Digital Diagnostic Atlas and the 'Basin Planning Working Group' meeting in Mary, Turkmenistan (*photo:* Maral Nuryyeva)

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