THE FLOOD FORECASTİNG
AND PRECİPİTATİON MEASUREMENT
BY USİNG RADAR SYSTEM

TEFER PROJECT İN TURKEY

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ABSTRACT

Until 1998, Turkey carried out the flood related activities, generally as structural measures in the river basins so as to reduce or eliminate long-term risk in the sensitive areas to the floods and water erosion. DSI has built dams, reservoirs, dykes, drop structures, weirs and channel improvements to minimize the adverse affects of floods on people.

The experiences gained from the floods of last decade show that structural measures implemented in the basin-wide are effective but too costly in reducing the risk of flood damages. Therefore, within the framework of Integrated Flood Management concept, after 1998 floods, more importance was given to non-structural measures, including flood proofing, early warning system, land use control especially at floodplains, flood disaster awareness creation, initiation of the concept of flood insurance, and timely and effective emergency management to be more effective for flood hazard management in the country

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INTRODUCTİON

In response to 1998 floods at western Black Sea region, the Government of Turkey with the assistance from the World Bank has identified an Integrated Flood Management programme, named TEFER (Turkey Earthquake and Flood Emergency Recovery) Project to develop flood management and to reduce or eliminate long-term risk and damage to people and their property from natural hazards. With TEFER, the urgent need in the flood prone area; which has been presented as case study from Turkey; the establishment of all kinds of structural and non-structural measures as flood control alternatives are being realized.

The project provides technical assistance to perform hydrometric network review and design and automated weather and hydrometric system design. In addition, the project supported the installation of about 129 automatic real-time hydrometric, 206 automatic real-time meteorological and 5 Doppler radar stations so that real-time data be available in order to run the operational flood forecasting models. Data integration is one of the highest concerns. The integration of the rainfall-runoff routing model to incorporate hydrometric and automatic weather data, and real-time quantitative radar data, in real time, is required

Turkey Emergency Flood and Earthquake Recovery (TEFER) Flood Forecasting and Model Development
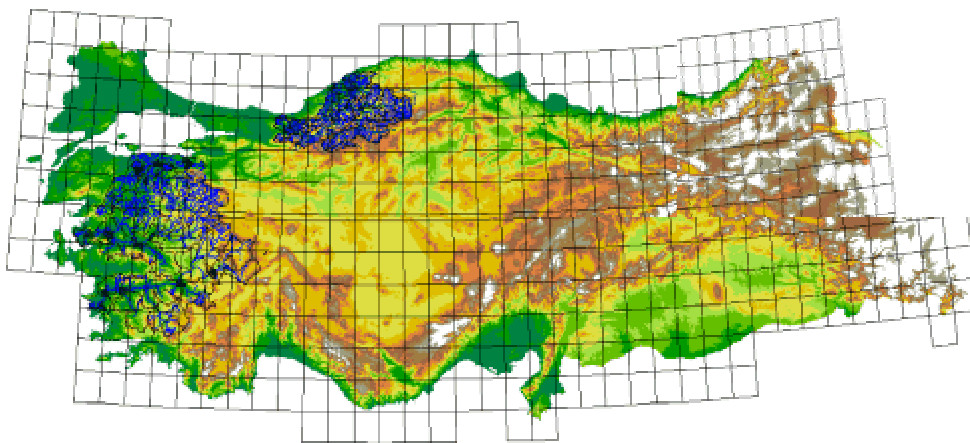
The contract for the Turkey Emergency Flood and Earthquake Recovery (TEFER), Flood Forecasting Model Development project was signed between the General Directorate of

State Hydraulic Works (DSI) and DHI Water and Environment, Denmark on 30th November 2001. Subconsultants to DHI for the project are einfalt & hydrotec GbR, Germany, and from Turkey Arti Proje Ltd and UBM United International Consultants Inc.

DSI has selected four pilot catchments for the establishment of the forecasting system: West Black Sea, Susurluk, Gediz and Buyuk Menderes, with catchment areas ranging from 18,000 to 30,000km2

Flood Forecasting System

The Flood Forecasting System developed under this TEFER component takes real time monitoring data of the catchment status and produces forecasts of the flood state of the catchment. The forecasting process is automated, with the possibility for manual inspection and intervention. Below figure shows an overview of the Flood Forecasting Model System

The flood forecasting system takes real time monitoring data of the regional meteorology and the catchment status, and produces forecasts of the flood state of the catchment. The forecasting system is based on FLOOD WATCH and SCOUT. FLOOD WATCH is a GIS based decision support system for flood management, with MIKE 11 at its core. SCOUT integrates real time numerical weather prediction, radar and raingauge data to produce rainfall forecasts. The system combines the compilation of real time data with rainfall and flood forecasting and presentations of the information and results.

Forecasting Operations

The TEFER Flood Forecasting Model has an interface to the telemetry system through the DSI central data server. This server is the ground station of the VSAT system at DSI. In addition to the computers and the VSAT ground station, a meteorological workstation from the TEFER Radar project will be included in the LAN of the flood forecasting centre.

A diagram of the data flow is shown in figure below. The overall data communication context is as follows:

- measured hydrometric field data are delivered either via VSAT (satellite communication) or via GSM/modem connection to DSI

- AWOS (Automated Weather Station) data are provided by DMI (State Meteorology Organization) via a dedicated data line to DSI

- the arriving hydrometric and AWOS data are transformed from their original formats to the format specified for the Flood Forecasting Model

radar and NWP (Numerical Weather Prediction) data are provided by DMI via a dedicated data line to DSI

SCOUT

The SCOUT module produces rainfall forecasts in real time from an integration of the radar data, the Numerical Weather Prediction (NWP) data, and the point raingauge data from the real time networks of DSI and DMI. The raw data are preprocessed, including quality control. The forecasts are transferred in real time to FLOOD WATCH as time series for each model sub-catchment.

SCOUT carries out the following functions:

- Import of radar and raingauge data
- Quality control and adjustment of data
- Forecasts computed from the integration of catchment topography and NWP data
- Presentation of measured radar images, individual and composite, raingauge data and rainfall forecasts
- E-mail reports of system performance

FLOOD WATCH

The flood forecasting and warning system is set up within FLOOD WATCH, a decision support system for flood management, developed by DHI Water and Environment.

FLOOD WATCH combines the compilation of real time data with rainfall and flood forecasting and presentations of the information and results. FLOOD WATCH has a customised ArcView graphical user interface and includes the following facilities, with "push button" operations:

- Real time data management with preprocessing and quality controls
- An automatic interface with the real time rainfall and water level data provided by the hydrometric network
- An automatic interface with precipitation fields predicted and measured
- Operation of the flood forecasting system
- Graphical and tabular presentation of the monitored data and the flood forecasts, with direct broadcast to the Internet
- Preparation of flood warnings, in textual, tabular, graphical and map based formats, with direct broadcast to the Internet

FLOOD WATCH operates within the environment of a Geographic Information System, and has an automatic interface with the data in the hydrometeorologic and hydrometric network database. All the thematic maps and information from GIS are available within FLOOD WATCH. The setup of the FLOOD WATCH time series database is prepared from the thematic maps with the locations of the stations in the real time network.

At the core of the FLOOD WATCH system is MIKE 11. MIKE 11 incorporates hydrologic and hydraulic modelling and is set up for the catchment area and the river network. MIKE 11 has a unique self-correcting updating procedure, automatically minimising deviations between the real time observed and simulated discharges and water levels. Updating is transparent to the user and by compensating for errors and uncertainties, particularly in the rainfall forecasts, greatly enhances the accuracy of the forecasts.

TEFER Flood Forecasting Model Interface Specification

This document describes the assumptions and definitions made in order to provide an interface between the TEFER Flood Forecasting Model and the telemetry system through the

DSI central data server. This server is the ground station of the VSAT system at DSI (see figure 2, TEFER Final Report Component 2, Hydrometric Network Review). In addition to the TEFER computers and the VSAT ground station, a meteorological workstation from the TEFER RADAR project will be included in the LAN of the flood forecasting centre.

A diagram of the data flow is shown below. The exact configuration of this scheme outside
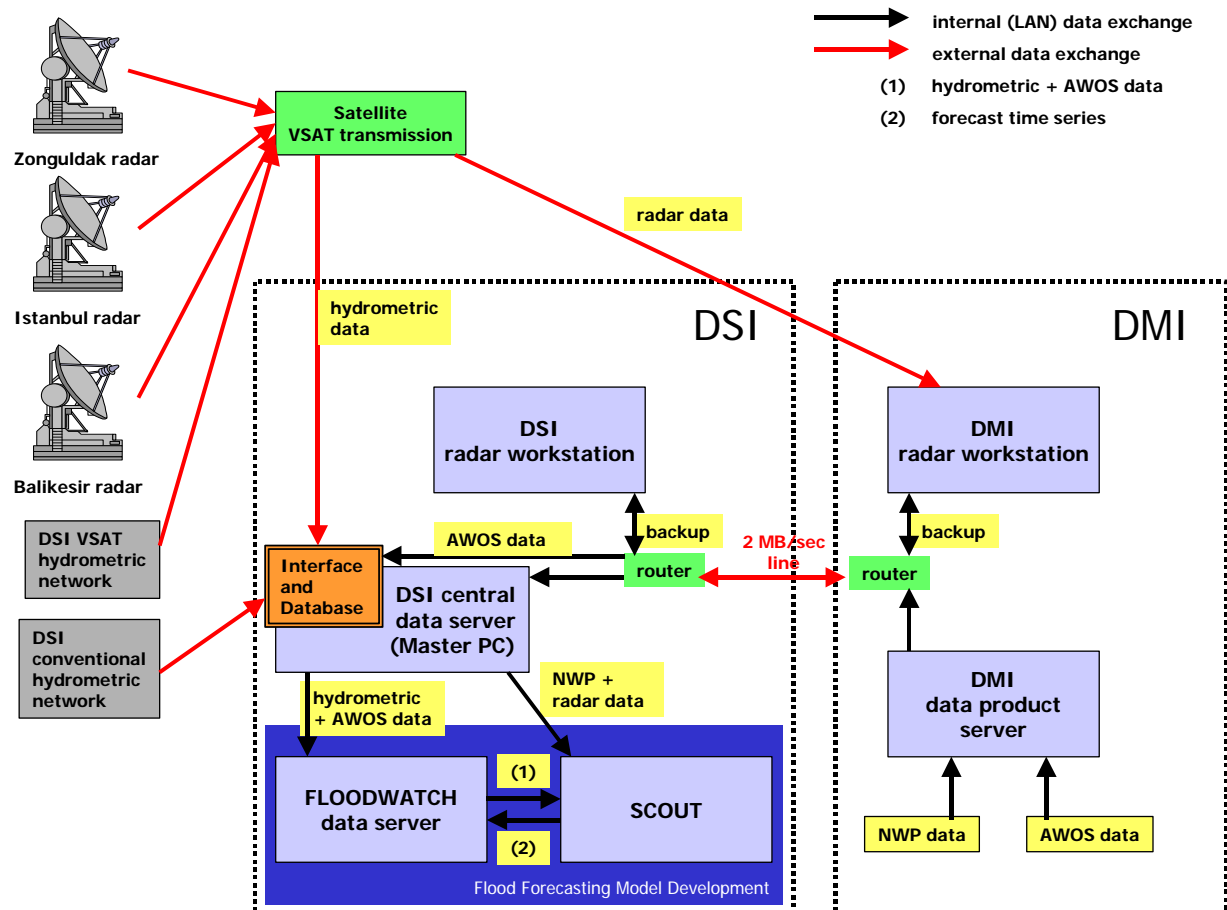
the Flood Forecasting Model Development should be verified with DSI, DMI and the individual component suppliers.

Data Flow Scheme relative to TEFER Flood Forecasting Components

The overall data communication context is as follows (see interface scheme below):

- measured hydrometric field data are delivered either via VSAT (satellite communication) or via GSM/modem connection to DSI
- AWOS data are provided by DMI via a dedicated data line to DSI
- the arriving data are transformed from their original formats to the format specified for the TEFER Flood Forecasting Model below
- radar and NWP data are *not* part of this interface

All incoming data will be written to an Oracle database in a format to be prepared by the supplier and approved by DSI. The database is for storage, and not a part of the interface specification.
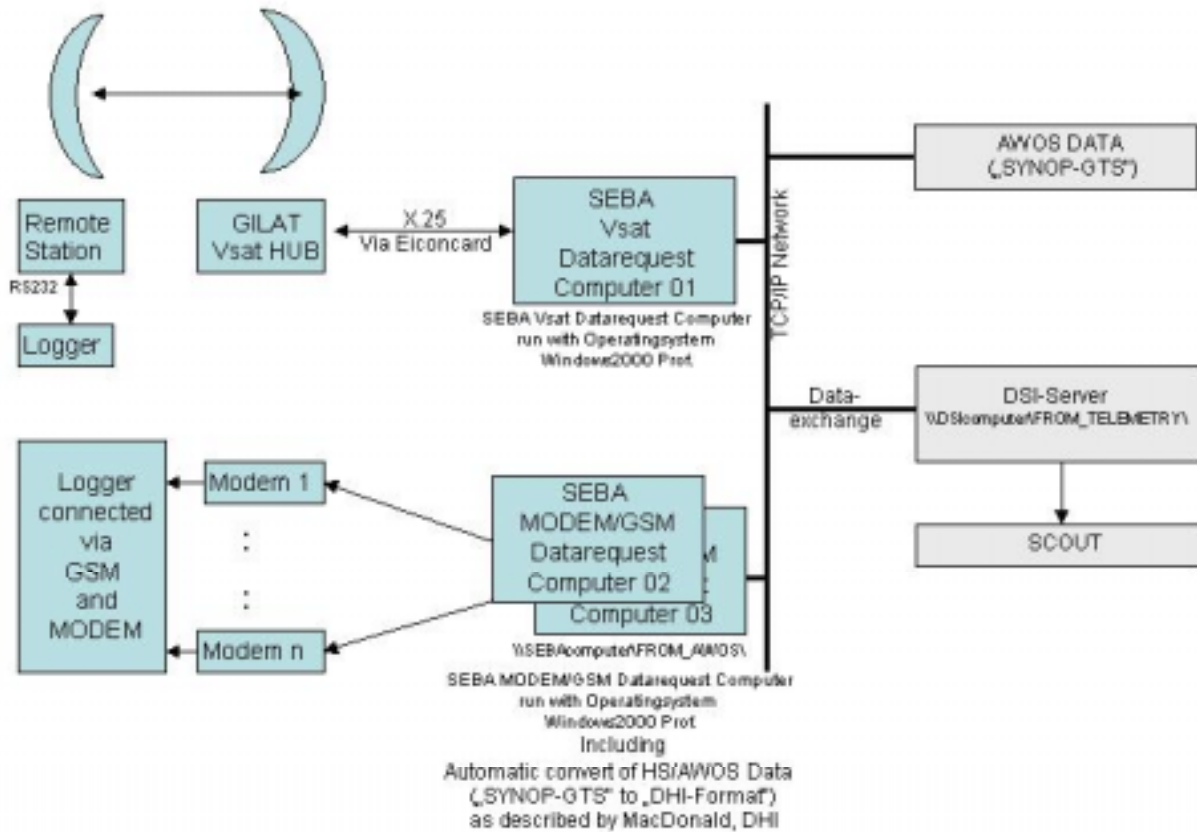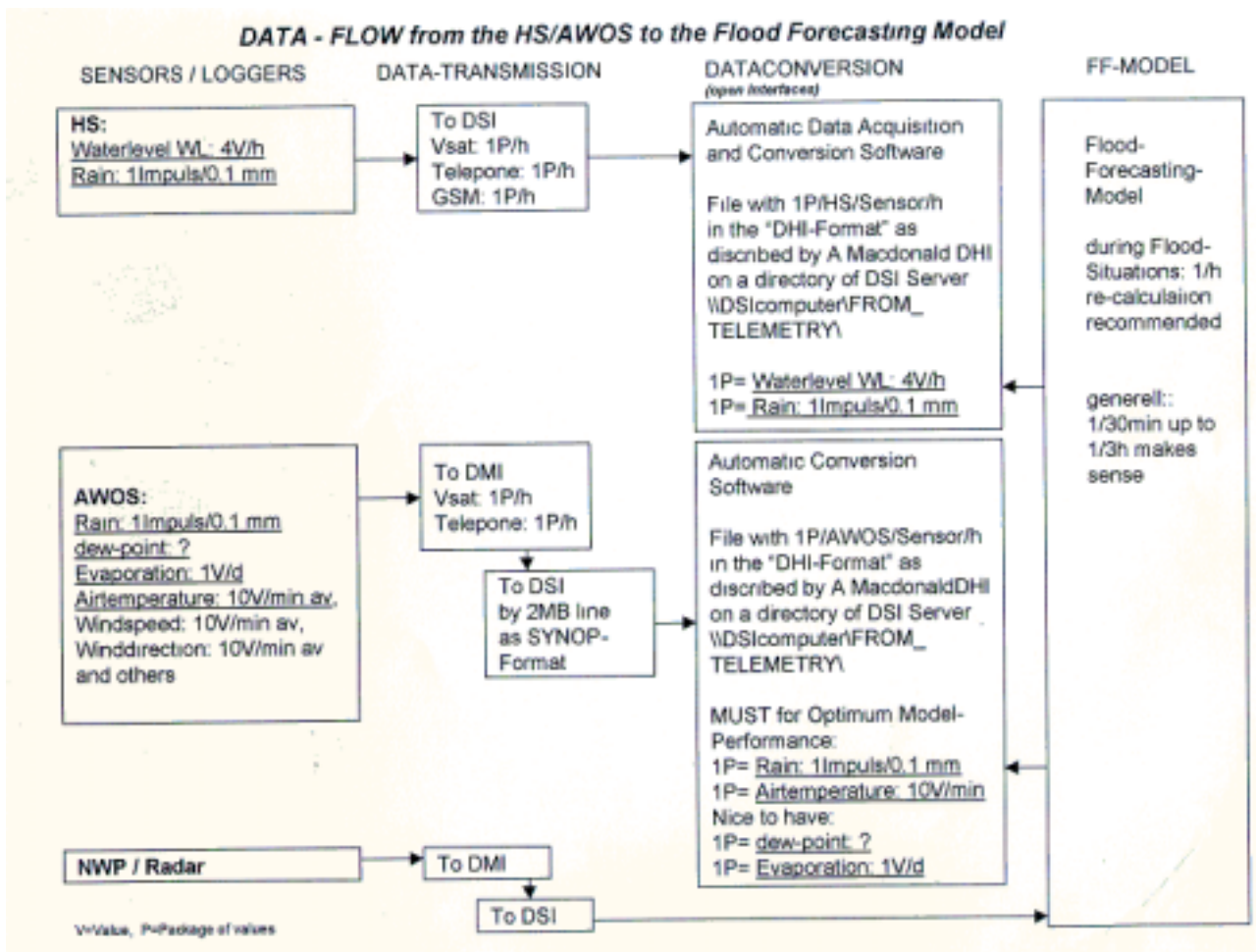

Interface Scheme relative to Communication Components (prepared by SEBA)

Interface Specification

FLOOD WATCH is the central module for data exchange on the Flood Forecasting side. It resides on a computer which is connected via LAN to the DSI central data server. The following components are required by FLOOD WATCH:

1. An indicator file in a specified directory for FLOOD WATCH to monitor. The existence of this file tells FLOOD WATCH that new data have arrived.

2. Incoming data automatically output in an export file located in a specified directory. Once the indicator file is produced any new data will be written in a new export file. The indicator file contains the names of the accompanying export files.

Interface Scheme relative to Iinformation Flow Components (prepared by SEBA and DHI)

Thus FLOOD WATCH needs two items as specified below:

1. An indication that new data has arrived in the system. These files will have the following names, content and location:

   File name: **VSAT_BATCH_yyyymmddhhmmss.TXT** (telemetry data) and

   AWOS_BATCH_yyyymmddhhmmss.TXT (AWOS data)

   Content: A list of the export files produced since the previous indicator file was made.

   Location: a shared folder in the DSI computer, **\\<DSIcomputer>\FROM_TELEMETRY**

2. The new data, see file format below.

The data will be provided automatically and the data exchanged in the form of files in predefined formats and locations. FLOOD WATCH will have no direct communication with VSAT, but act as a receptor of the incoming data.

Data Streams

FLOOD WATCH assumes all incoming station data will be available on a central DSI server, which is in charge of communicating with external systems providing data for the flood forecasting model. The radar data and NWP data are supplied through the meteorological workstation situated at DSI through the TEFER RADAR project. These data are directly taken over by SCOUT (the rainfall forecasting module) and are not an item in this specification.

Telemetry data and AWOS data are placed on the DSI server in a specified directory at regular intervals or when data are ready. FLOOD WATCH will normally run models hourly and should receive observations accordingly - it will use whatever data are available. A defined naming standard of files, directory structure and file layout will be observed (see below).

In the FLOOD WATCH database server a process monitors the DSI server directories. When new data are ready, the files are treated as follows:

- Telemetry and AWOS data are received and stored in the FLOOD WATCH database. Quality control procedures and processing are performed on data as they arrive. A batch of files is processed into the FLOOD WATCH database and once received the files will be removed from the DSI server.

Specification for Telemetry Data Interface

Telemetry data will be received in ASCII file format (see also the following section on AWOS data). Every transmission of data (batch) consists of a set of files - one for each sensor plus one file describing the files in the batch. This will allow a new batch to be created during the processing of a batch.

The batch description file will be named **VSAT_BATCH_yyyymmddhhmmss.TXT** where yyyymmddhhmmss gives the time of the batch to the second. An example of the file name is:

VSAT_BATCH_20020501172745.TXT

The content of the batch is all the file names in the batch, one file name per line. Each data file in the batch is named with the the parameter identifier, the station identifier and the time of the batch:

\<parameter\>_\<station\>_yyyymmddhhmmss.DAT

Valid parameter IDs are:

- r: rainfall [mm]
- w: water level [cm]

Valid station IDs comprise a number of characters between two underscores. This means that underscore ('_') cannot be part of a station name. Examples of such file names are:

    w_27853_20020501172745.DAT
    r_13-14_20020501172745.DAT

Each file contains one reading per line, with no header. Readings are in the form:
yyyy mm dd hh mm ss value

Example of content:
    2001 12 27 14 05 00   123.456
    2001 12 27 14 15 00   23.756
    2001 12 27 14 25 00   123.245

Specification for AWOS Data Interface

The radar data processing and forecasting software SCOUT requires data from radar, NWP and raingauges. Measurements of temperature and, if available, dew point temperature or evaporation are used for the flood forecasting part of the models in the TEFER Flood Forecasting Model Development project.

AWOS data will be available on the central server at DSI (DSI central data server), from which the flood forecasting system may retrieve the data. The setup will be:

- AWOS data will be received in ASCII file format
- Every transmission of data (batch) consists of a set of files - one for each parameter plus one file describing the files in the batch. This will allow a new batch to be created during the processing of a batch.

- The batch description file will be named:

  AWOS_BATCH_yyyymmddhhmmss.TXT

  where yyyymmddhhmmss give the time of the batch to the second, eg

  AWOS_BATCH_20020501172745.TXT

The content of the batch file is all the file names in the batch, one file name per line. Each data file in the batch is named with the parameter identifier, the station identifier and the time of the batch:

<parameter>_<station>_yyyymmddhhmmss.DAT

Valid parameter IDs are:

- r: rainfall [mm]
- t: temperature [°Celsius]
- d: dew point temperature [°Celsius]
- e: evapotranspiration [mm]
- s: snow depth [cm]

Valid station IDs consist a number of characters between the underscores. This means that underscore ('_') cannot be part of a station name.

Examples of such file names are:

      e_27853_20020501172745.DAT

      r_13-14_20020501172745.DAT

      t_27853_20020501172745.DAT

Each file contains readings in the form:

yyyy mm dd hh mm ss value

One reading per line, no header.

Example of content:

      2001 12 27 14 05 00 123.456

      2001 12 27 14 15 00   23.756

      2001 12 27 14 25 00 123.245

      2001 12 27 14 35 00 111.999