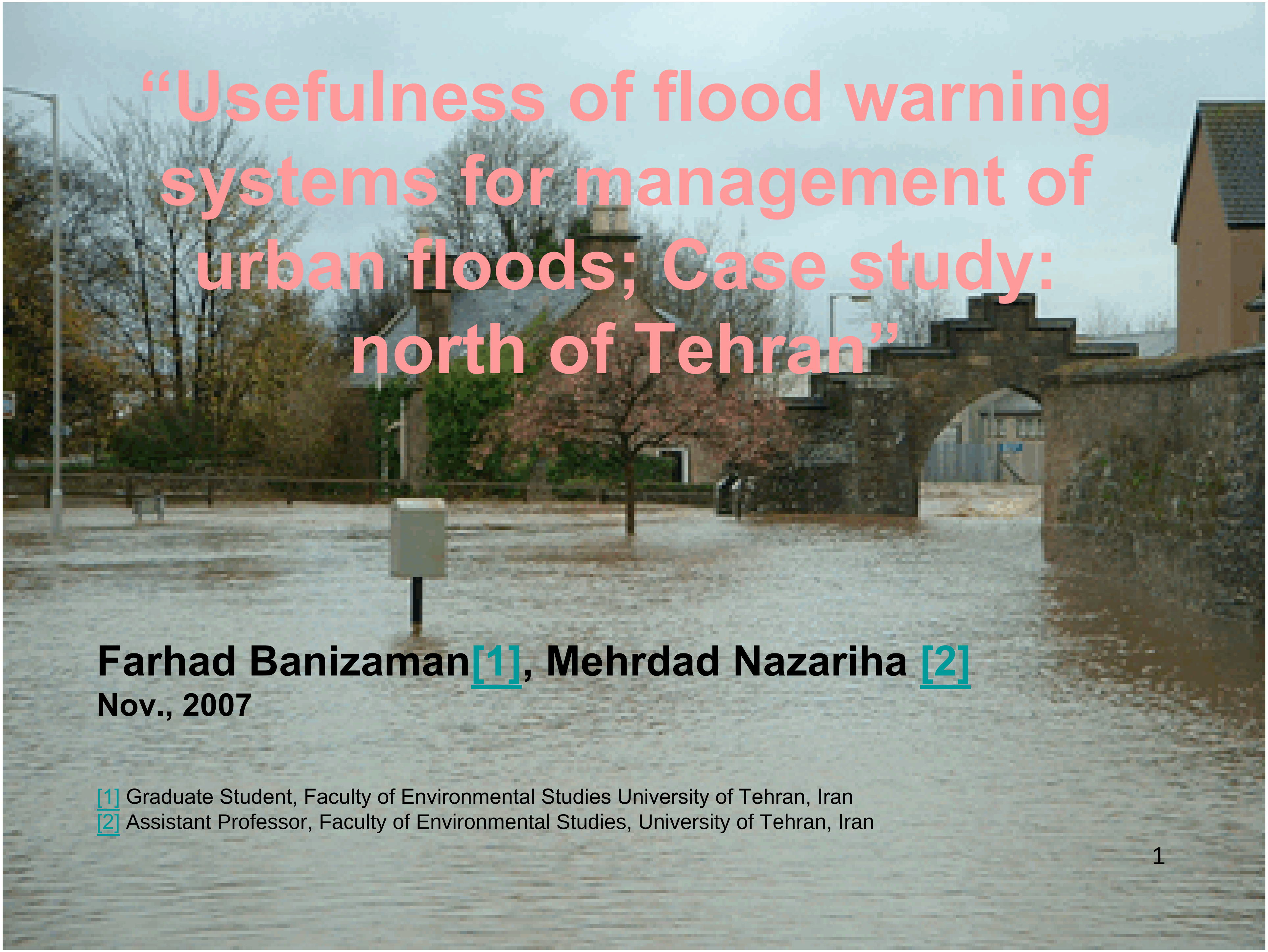


“Usefulness of flood warning systems for management of urban floods; Case study: north of Tehran”

Farhad Banizaman[1], Mehrdad Nazariha [2]

Nov., 2007

[1] Graduate Student, Faculty of Environmental Studies University of Tehran, Iran
[2] Assistant Professor, Faculty of Environmental Studies, University of Tehran, Iran

- Floods cause life casualties each year in Iran and elsewhere. Many regions experience severe flooding from natural sources.
- The Golabdarreh flash flood in 1987 discharged about 250m3/s runoff (excluded debris) in 30Km2 watershed area that caused more than 300 life casualties. A huge amount of mud, boulders and stones were deposited on the streets of northern Tehran. Many houses and other proprieties were also buried under sediments.

This paper presents the development of Flood Warning Decision Support System (FW-DSS) in the north part of Tehran in Iran, with the potential of extension to other locations with similar flooding problems.

- This paper covers different aspects of the DSS prototype developed under this project.

The most common types of flooding includes:

basins at the middle and lower courses of rivers and due to flash floods caused by intense local or regional precipitation.

- This paper also focuses on flash floods, where the target area is located. These floods are often characterized by a short response period and a few hours of inundation.

The study reveals the complexity and uncertainty involved in managing flooding in the study areas. Issues about the validity and extended benefits of the system are also discussed.

The problem is more important in urban areas where the land use changes is evident due to urban development.

- More sever floods may occur If the topography is such that a rapid buildup of storm conditions is expected.
- The recent flood in Golabdarreh was an example of urbanization effect on severity and rapidity of flooding in mountainous areas of northern Tehran.
- A high runoff rate and more rapid catchment responses was experienced.
- Flood forecasting and flood warning system have been found necessary to take proper action. Flood warnings, planning emergency activities and initiating restoration.
- The purpose of the DSS is to manage the dynamic data along with relevant static data to an array of modeling tools, forecast flooding conditions and assist public authorities in decisions regarding emergency measures.

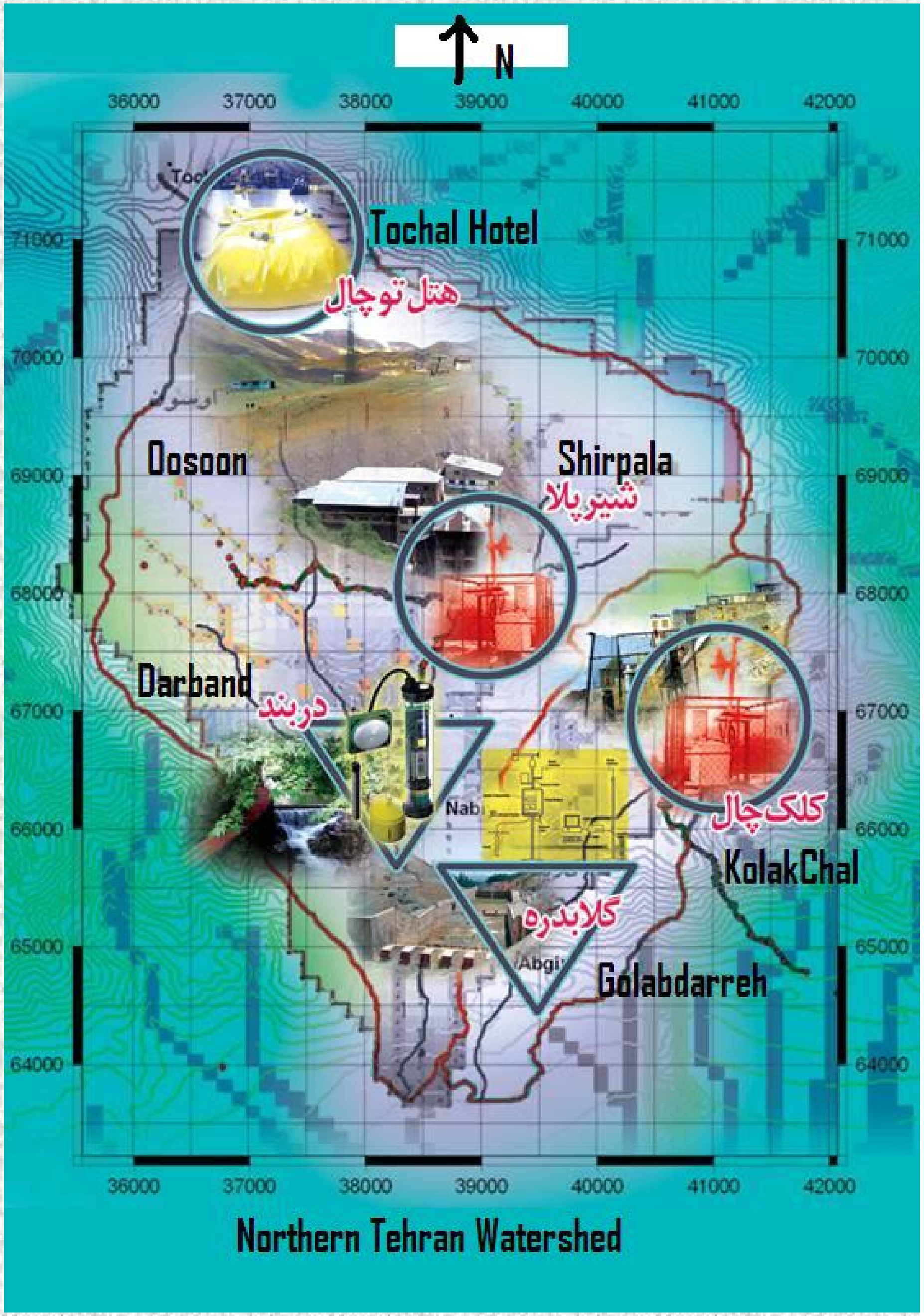
Simonovic (1999) defined a DSS: “A decision support system allows decision-makers to combine personal judgment with computer output, in a user-machine interface, to produce meaningful information for support in a decision-making process. Such systems are capable of assisting in solution of all problems (structured, semi-structured, and unstructured) using all information available on request. They use quantitative models and database elements for problem solving. They are an integral part of the decision-maker’s approach to problem identification and solution”.

The objective of the paper was to determine the configuration and process of flood warning system implementation for handling urban flood emergencies with in advance forecasting using FW-DSS. The target area is the Golabdarreh in Tehran in which a severe and devastating flooding was observed in 1988.

Land Use Change From 1988 to 2001

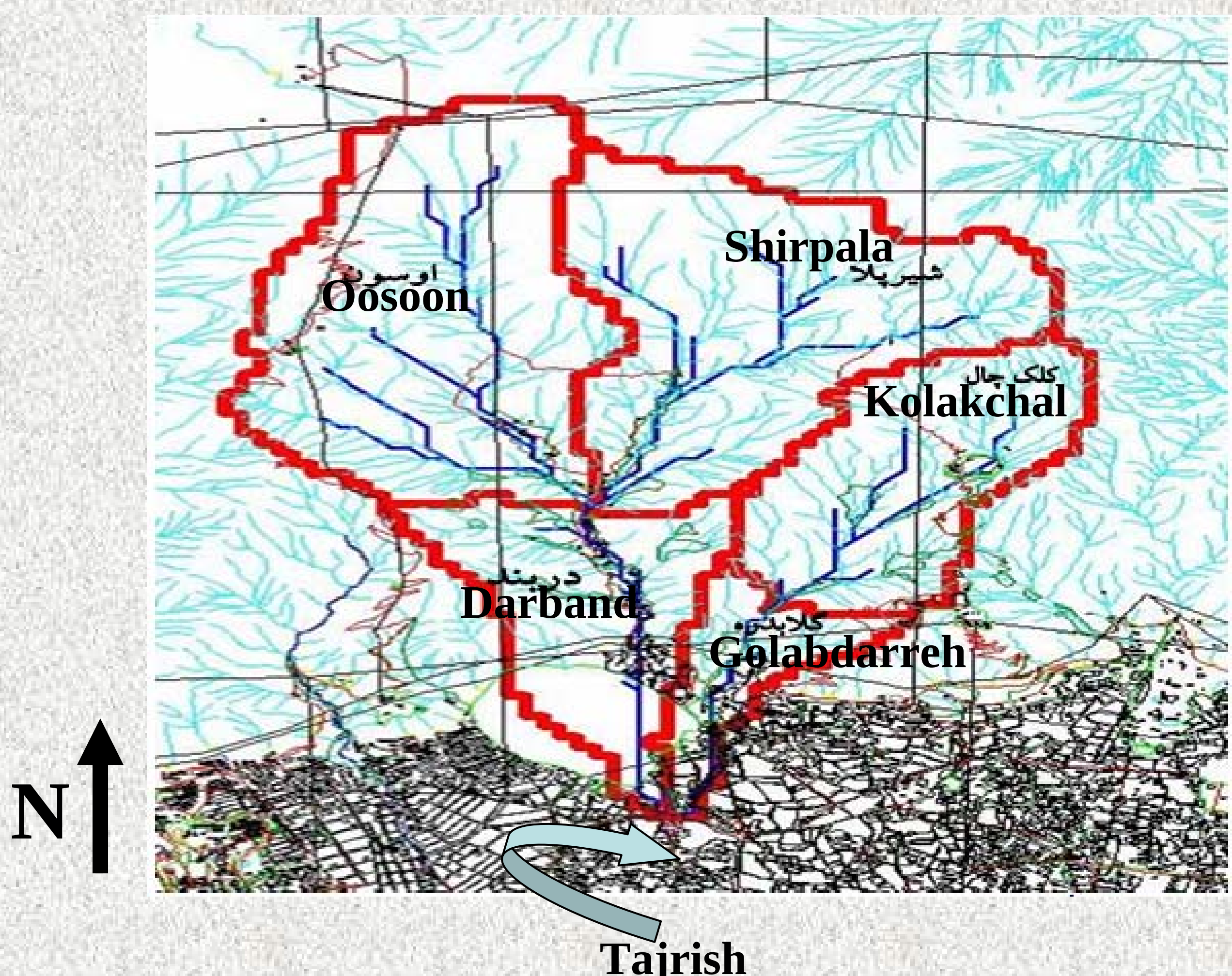
No.	Land Use	1988(%)	2001(%)
1	Green spaces	27.22	14.8
2	Bare Soil	71.38	73.45
3	Urban area	1.4	11.35
Total		100	100

Overview



Aerial Photo of the study area at the north of Tehran

Golabdarreh Basin and its sub-basins



Annual Average Precipitation Data for different sub-basins in the study area

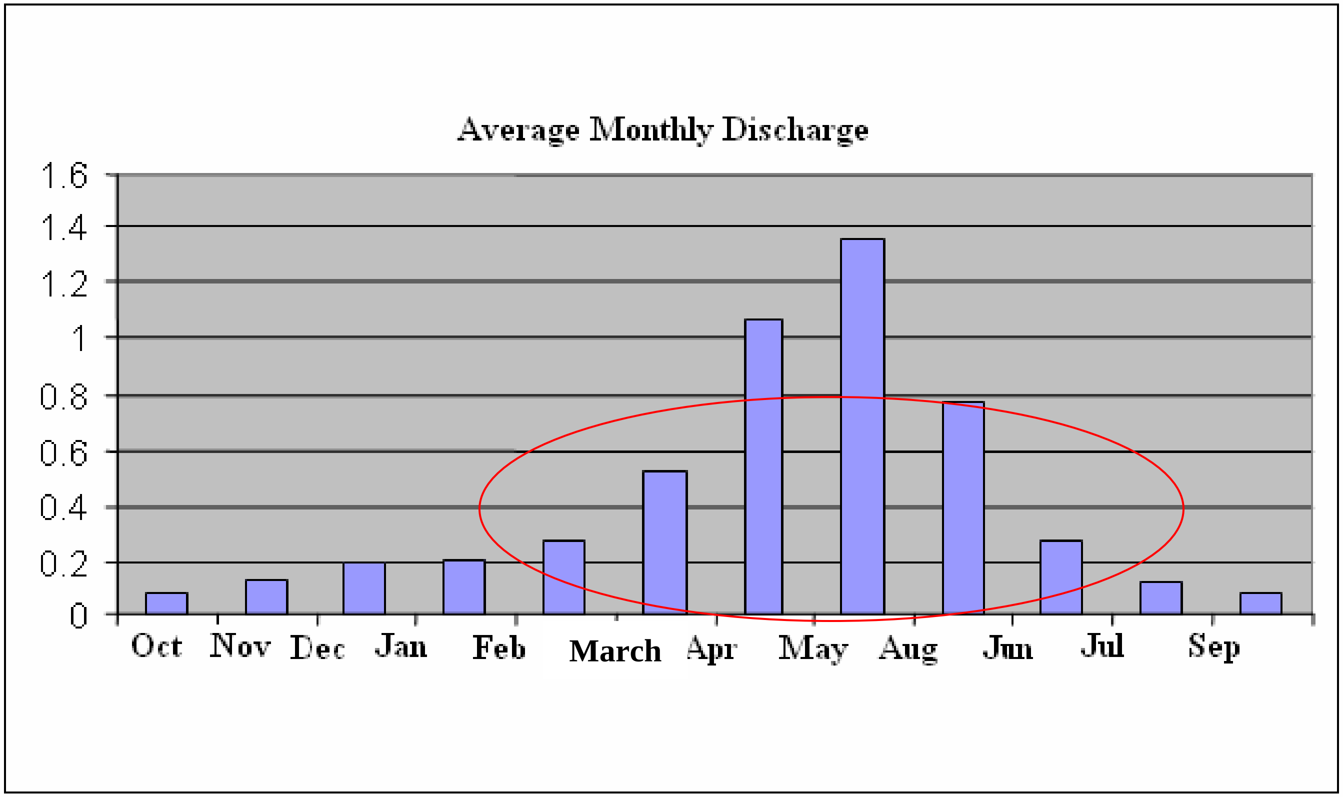
Sub-basin	Darband	Golabdarreh	Kolakchal	Shirpala	Oosoon
Time of concentration (hour)	0.89	1.23	0.61	0.79	0.86
Precipitation (mm)	482	450	533	567	574

Average Annual Precipitation for the study area (532.6mm) is greater than that of the northern Tehran (399.0mm)

Historical Events in Tehran

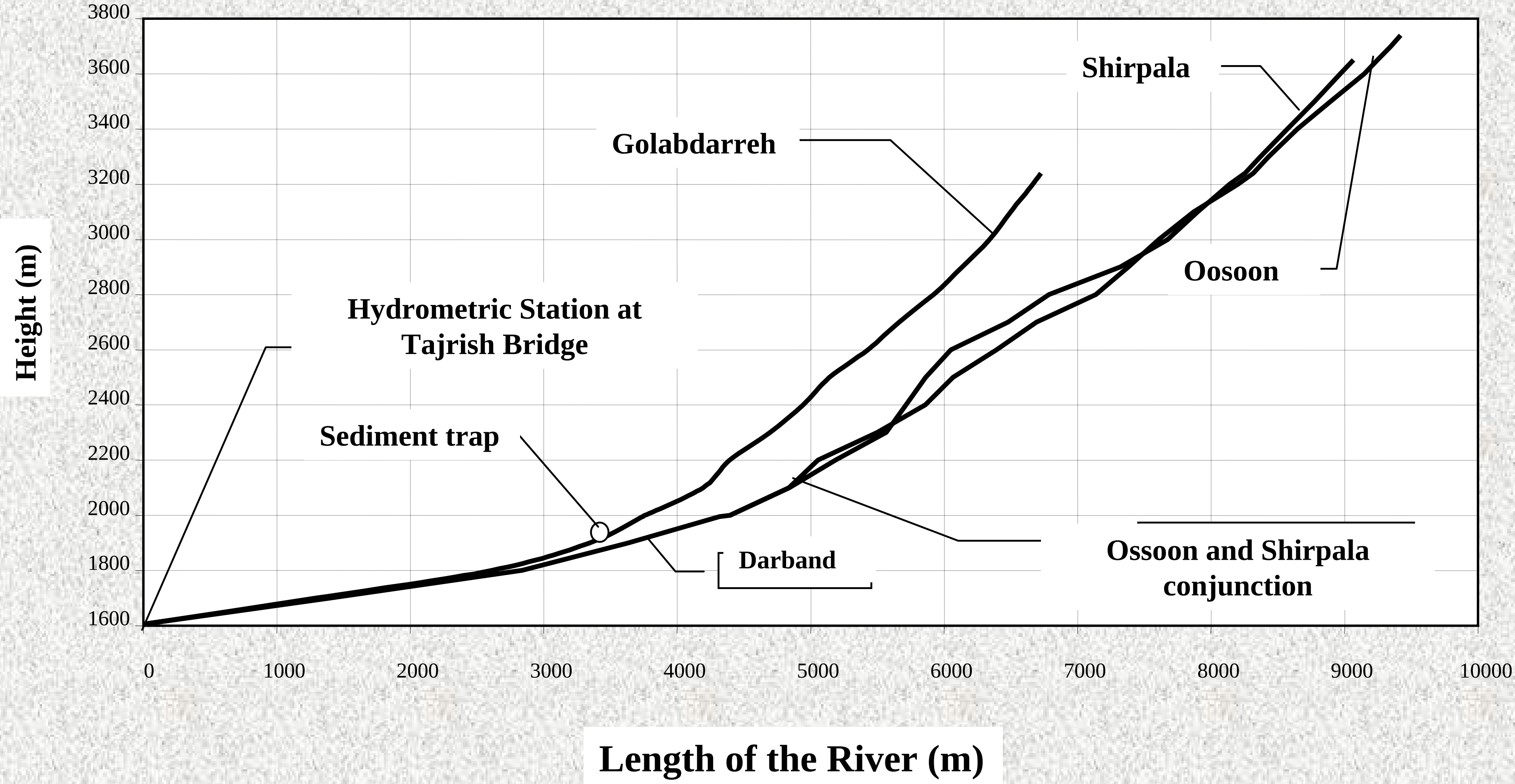
Discharge rate (m3/s)	Discharge (m3)	Flood duration	Casulties	Year
45 (1 hour rainfall)	12000000	21.5 hours	Many life losses and 1200 houses were destroyed	1867
	10 cm debris and mud	-		1937
22mm rain in 1 day	165000	2 days		1954
100m3/s	1100000	2 days	300 people died	1987

Average Monthly Discharge in m3/s



Computed Floods for different return periods are as follows

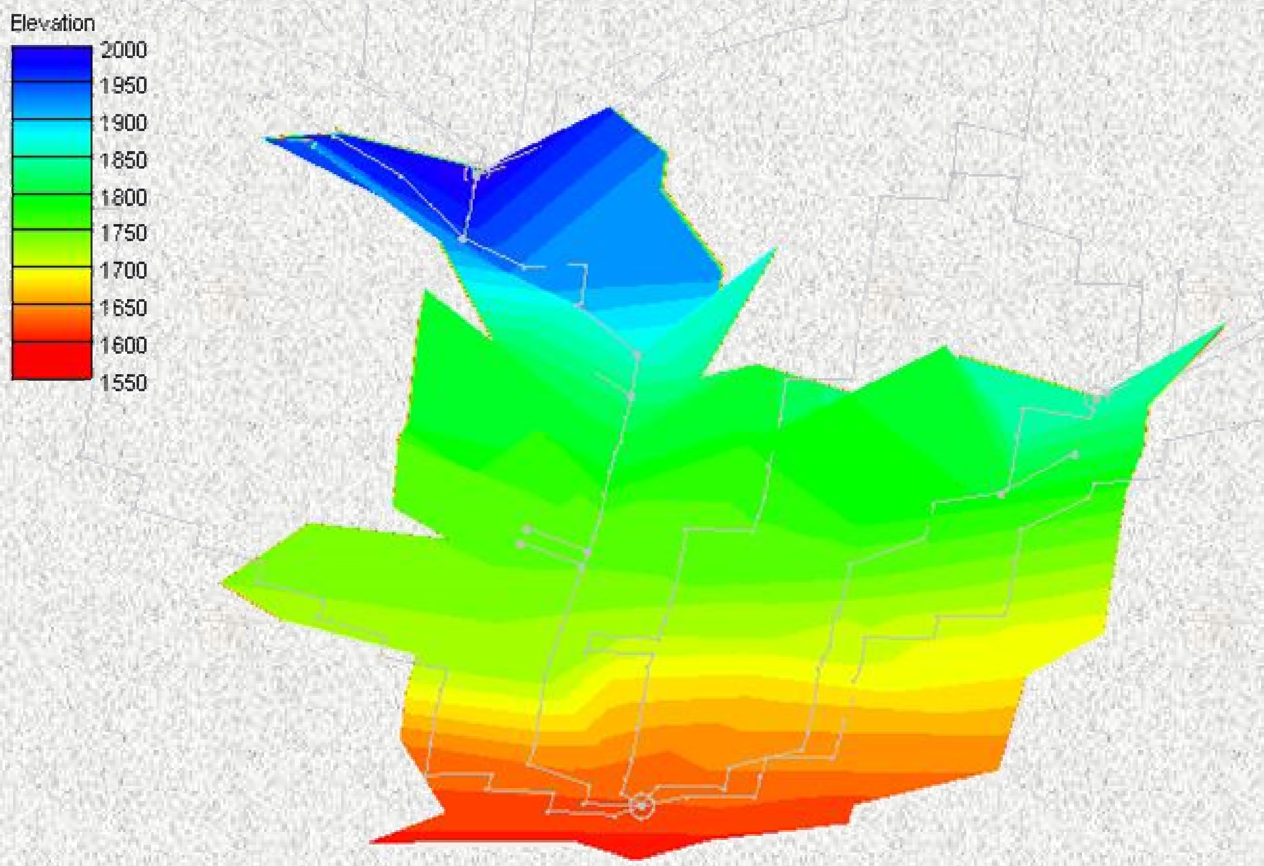
Return period	2	5	10	20	50	100	200	500
Instant discharge (m3/s)	7	19	31	49	84	122	174	271



Longitudinal Profile of Golabdarreh and Darband Rivers (Kurit Kara Eng. Consultant, 2006)

- The length of the Golabdarreh River is about 3700 m, with the mean slope of 0.0867 that originates from the mountains at the level of 1927m that ends at 1607m from sea level. However, the mean slope of the Golabdarreh and Darband sub-basins are 41.8% and 45.6%, respectively.
- The main part of the river has natural bed, however, when the river reaches to the urban area its bed changes to the concrete canals that consists of several drops, sediment traps. Also the river is partly covered by concrete blocks.
- Along the river several bridges and culverts exist that may contribute to flooding.


3D Flood plain water elevation for Golabdarreh River (Blue line is the highest and the red one is the lowest water elevation)



Forecast centers

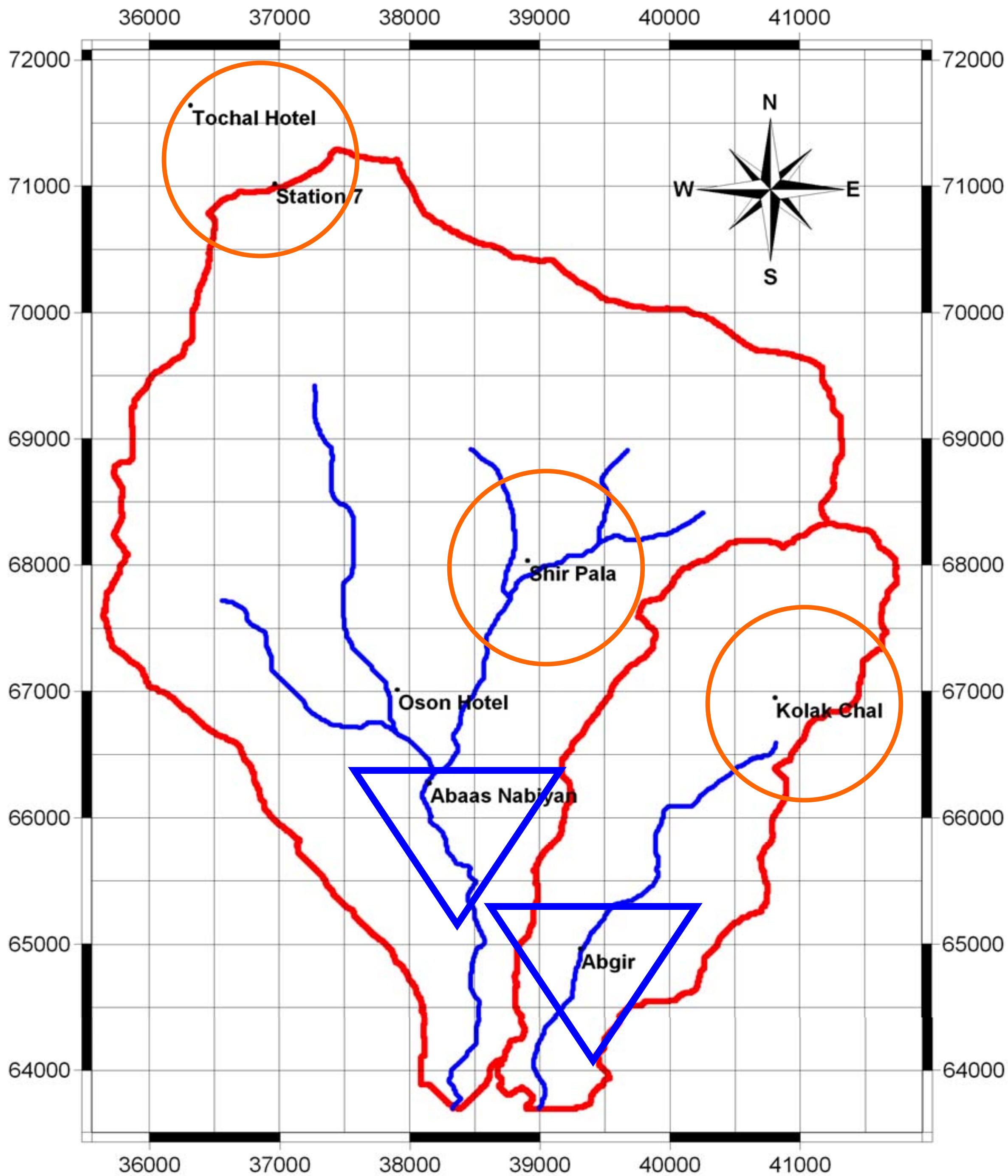
- The flood forec13ast centre must be identifiable to agencies and to the public as the authoritative source of flood forecasts and warnings. The forecasts produced by the centre must be to the highest achievable technical standard and be released to the public unfiltered by agency or political interests. The long-term stability of the centre is dependent on the credibility and utility of its forecasts.

- Since the watershed area is small and related time of concentration (almost equals to warning lead-time) is as low as about 1 hour, only one central forecast station is enough for flood warning system. Other stations can receive information from this central station.
- Decision makers in charge who are in stations in Tehran have an independent system of communication which is different from flood warning system.
- Three observation sites are necessary to record rainfall within watershed area (Fig. on the next page).
- Two hydrometric stations are proposed to record river flows (Fig. on the next page).

Rainfall Observation site

Hydrometric station

Proposed forecast sites and centers



Usefulness of Decision Support System for Flash Flood Warning

- According to Kanbua and Khetchaturat (2006), the potential benefit of a flash flood forecast depends on three main factors.
- Firstly its accuracy, which in turn depends on the accuracy of the forecast data, the observational data and the numerical weather modeling and updating procedures.
- Secondly the magnitude of the lead time it provides before critical levels are reached which can be improved by using quantitative precipitation forecasts from meteorological satellite cloud image, weather radar and numerical weather prediction models.
- Thirdly, the benefits depend on the effective use of the forecast information, for flood monitoring, flood warning, the operation of flood protection structures and the evacuation of people and livestock. This requires appropriate decision information in a timely manner to those who need it, where they need it, in a manner that is easy to understand.

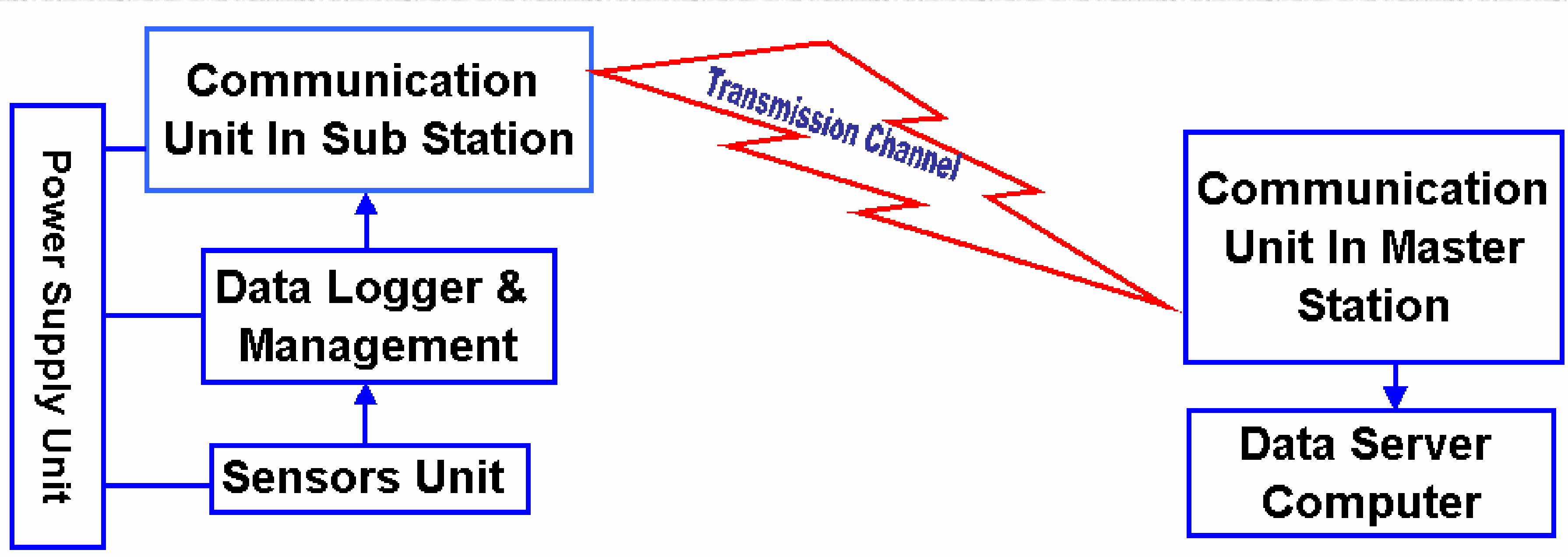
Data acquisition system

- Based on required data, different types of data loggers are necessary.
- Because of mountainous characteristics of the watershed, one of the rain gauges should be equipped with snow-equal-water sensor, while in other locations only water level should be measured.
- In the case of flooding in different stations, devices for measuring rainfall, temperature, moisture, wind speed, water level, snow-equal-water and data loggers should be installed for the Flood Warning System.

Usefulness of FW-DSS

- The decision support system is found to be useful due to its interactive nature, flexibility in approach and evolving graphical feature and can be adopted for any similar situation to predict the critical level.
- The advantages of the FW-DSS are named as: increasing decision accuracy, accelerating the decision making process, and also to help ease the process. Above all, the uncertainty involved in decision making process will be decreased.

Schematic configuration of Telemetric systems



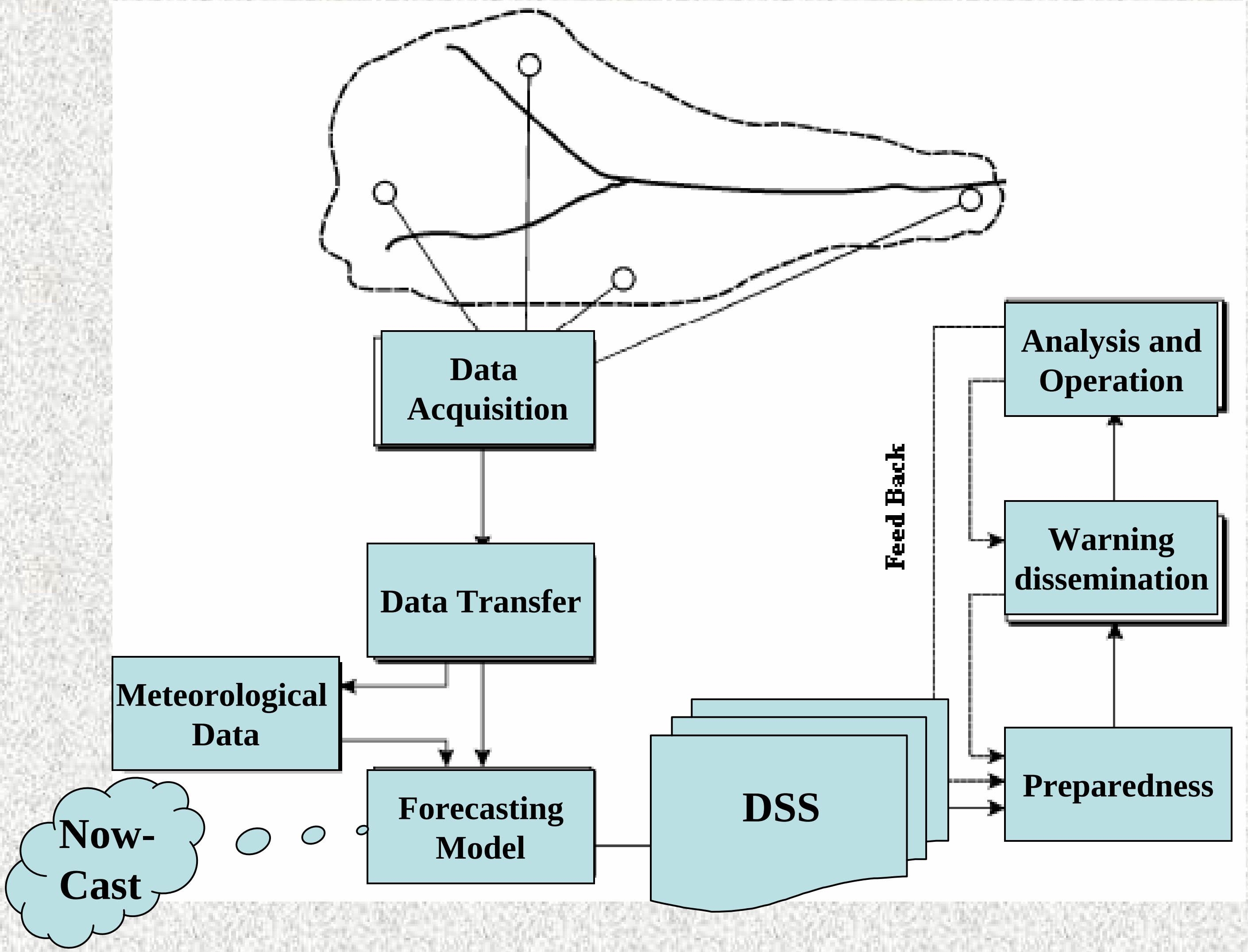
In different seasons, installed sensors should record data in periods as follows

	Rainfall	Temperature	Moisture	Wind speed	Water level	Snow-equal-water
During flooding	Every 1 (min)	Every 10 (min)	Every 30 (min)	Every 30 (min)	Every 60 (min)	Every 60 (min)
cold and wet seasons	15 (min)	60 (min)	60 (min)	60 (min)	15 (min)	12 (hrs)
Hot season	12 (hours)	12 (hours)	12 (hours)	12 (hours)	12 (hours)	12 (hours)

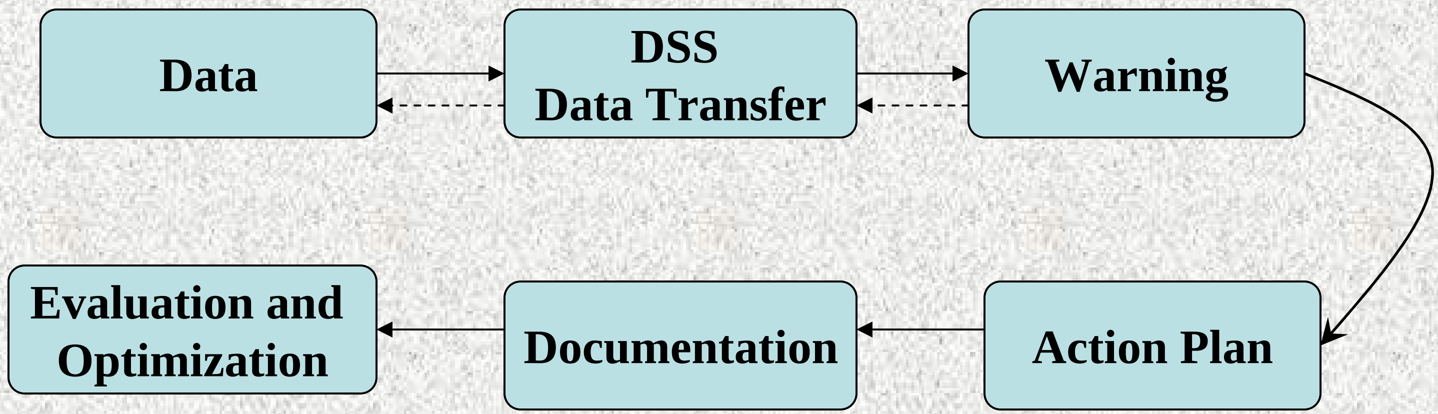
Application of DSS in Flood Warning System

- Due to complexity associated with flash flood process as well as limited time available for making decision, many lives may be in danger if proper decision is not made in shortest time as possible.
- DSS can be used as an efficient tool to help managers in decision making process during flood events.
- The effectiveness of a decision is mainly based on criteria that describes best the situation.
- DSS is the integration of methods, experts, software, computer models that work together in a cooperative manner.
- The basic role of DSS is data processing in order to reveal the priorities.
- In the Flood Warning application we need some realistic criteria to rely on, while the decision making is progressing.
- In the case of a flood event, observed precipitation height, discharge rate and meteorological conditions are very indicative.
- A common method to treat identification is to have some thresholds for precipitation height or discharge rate to be able to compare them with observed data.
- When observed data proceeds with the thresholds, it implies an alarm for the group of decision makers.

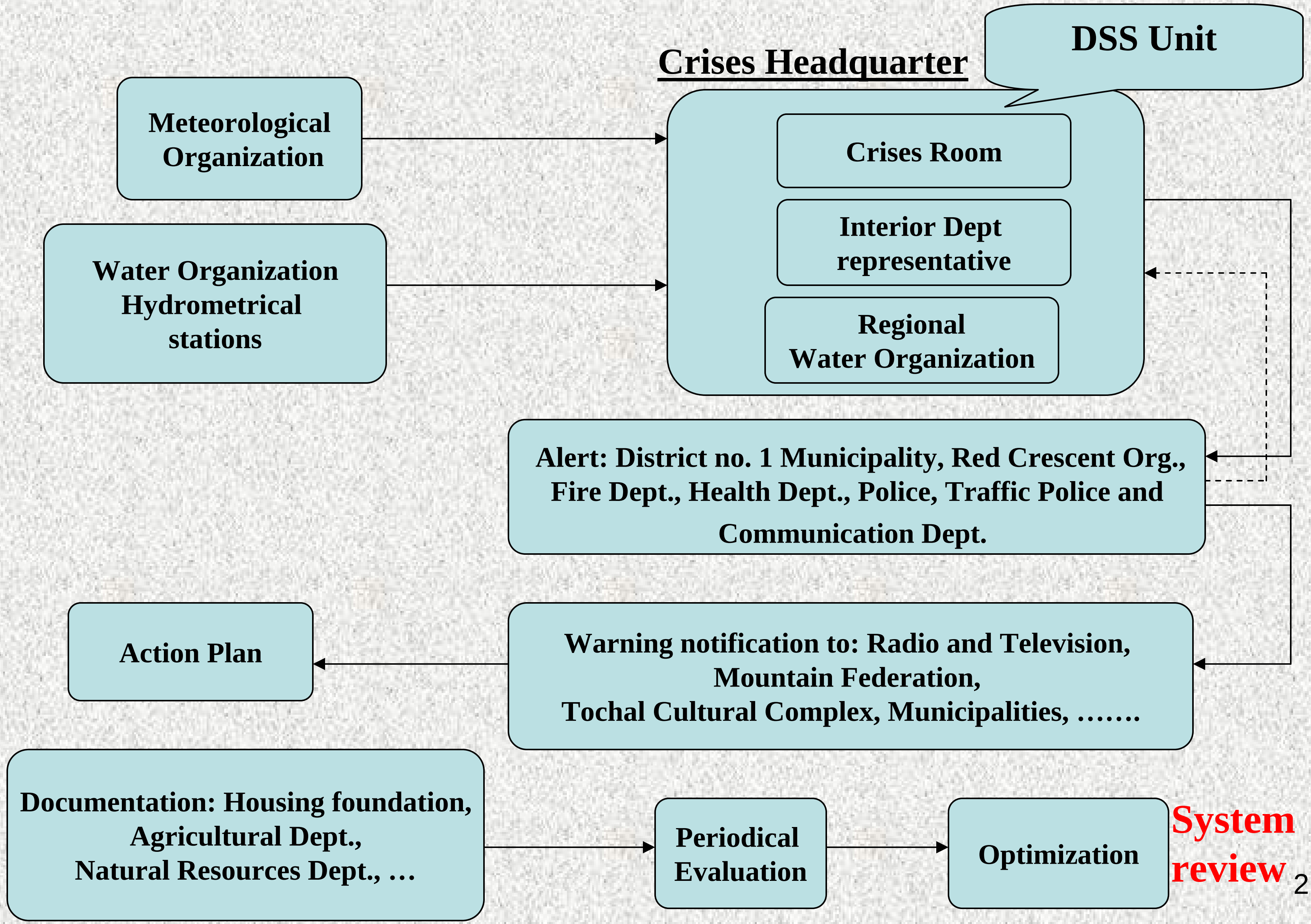
General Arrangement (GA) of FW-DSS



Implementation Chart for FW-DSS in The Study Area



Ideal Chart for FW-DSS in The Study Area



The role of community in flood emergency situation

- Community-base approach is among the promising approaches appeared in recent years in the area of emergency management.
- Volunteers can be reliable in communicating decisions taken by decision makers (either evacuation or sand-bagging) to the residents and even tourists.
- The education works efficiently to empower selected group of people in a community or neighborhood.
- The decision support system should be developed for flash flood warming with people participatory.
- The flood warning system should facilitate downstream communities people to be able to operate so that it can be used as a tools for making decision whether they suppose to evacuate or in what situation they should do in case of having heavy rainfall on the upstream.

Problems engaged

- Lack of sufficient data
- Lack of reliable past records
- Greatly human intervention with the study area
- Lack of measurements equipment
- Currently, public warnings, whether delivered by the Emergency Alert System (EAS) or specialized systems, do not reach enough people directly at risk and may unduly disturb and alarm many more people who are not directly at risk.

Conclusions

- Basin characteristics revealed that if there is sufficient lead-time available then, it would be very efficient in saving lives.
- Decision making in the least time is a troubleshooter to the problem
- There is of necessary to set an appropriate organization, man-power, software and hardware elements in order to joint operate in a manner to mitigate flood losses.
- Decision Support System in combined with flood warning application can be considered as a solution to the non-structured problems such as the case of the flash-flood events in Golabdarreh.
- DSS is greatly depending upon correct data accumulated from the source field.

Recommendations

- Community base approach can be a SOLUTION to the flood warning from the warning dissemination stage forward as in the case of Golabdarreh.
- It was recommended that in each station the central instrument should be used and be manageable so that data can be recorded in different seasons namely, hot and cold seasons and also wet season.
- The implemented system should be reviewed periodically in order to upgrade and also to update the application.
- The appropriate threshold parameters (precipitation or discharge rate) should be set so as to work as a back bone for decision making.
- Data should be transferred appropriately in a timely manner
- Complimentary Data stations should be installed.
- Community based approach should be taken into account in order to disseminate alarm or to communicate emergency messages.