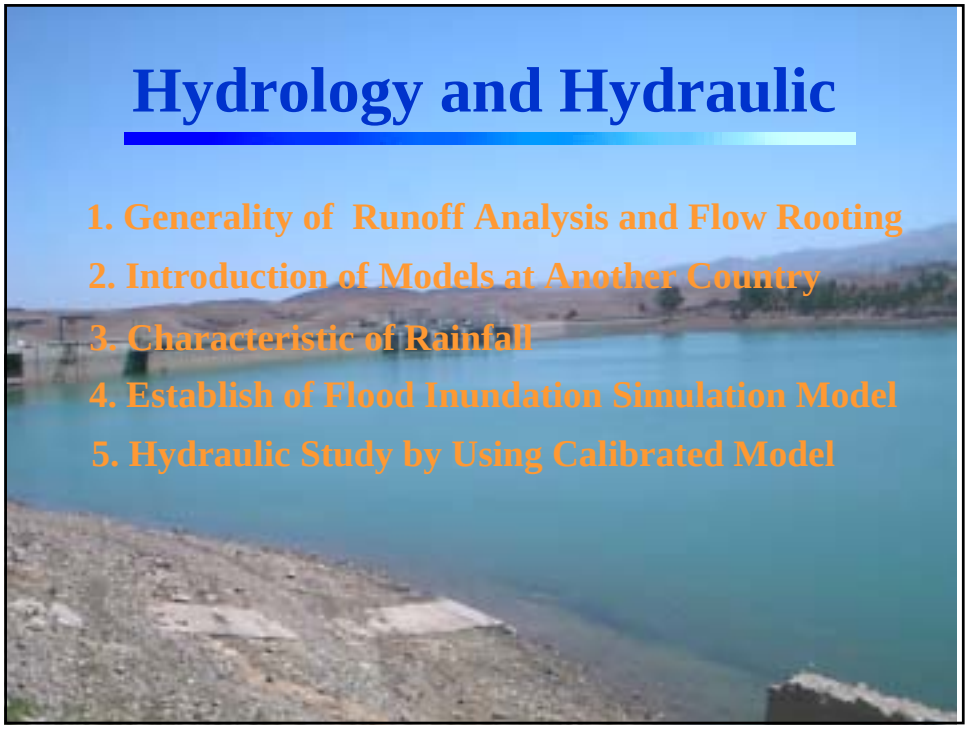
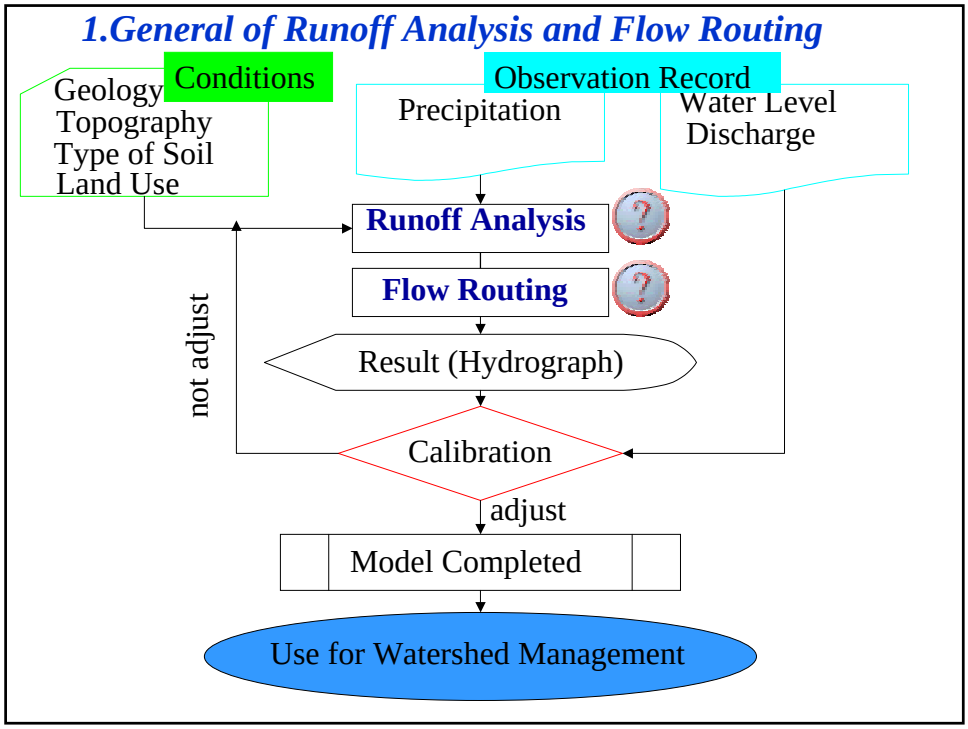

Hydrology and Hydraulic
1. Generality of Runoff Analysis and Flow Rooting
2. Introduction of Models at Another Country
3. Characteristic of Rainfall
4. Establish of Flood Inundation Simulation Model
5. Hydraulic Study by Using Calibrated Model


1.General of Runoff Analysis and Flow Routing
Conditions
Geology
Topography
Type of Soil
Land Use
Observation Record
Precipitation
Water Level
Discharge
Runoff Analysis
Flow Routing
Result (Hydrograph)
not adjust
Calibration
adjust
Model Completed
Use for Watershed Management

1.1 Runoff Method

Rainfall → Discharge

- Germany: Rational Formula
- America : Unit Hydrograph Method (1932)
- Japan : Storage Function Method (1955)

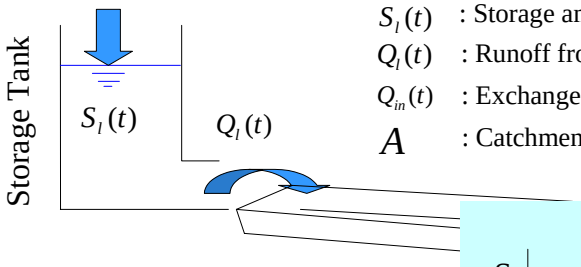
Runoff Method

Rational Formula	Unit Hydrograph Type (Linear)	Storage Type (Non-Linear)	Others
	•FSR •US SCS •Nakayasu •FEH	•Tank Model •Storage Function •Modified RRF	•Kinematic Wave •Quasi-linear Storage

1.2 Storage Function Method

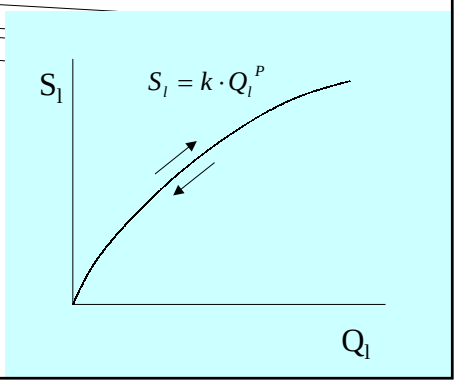
$$Q_{in}(t) = \frac{1}{3.6} r_e(t) \cdot A$$

$r_e(t)$: Mean Excess Rainfall (mm/hr)
$S_l(t)$: Storage amount (m^3/s hr)
$Q_l(t)$: Runoff from Storage Tank (m^3/s)
$Q_{in}(t)$: Exchange re to discharge (m^3/s)
A : Catchment Area of Sub-Basin (km^2)



Equation of Motion $S_l = k \cdot Q_l^P$

Equation of Continuity $\frac{dS_l}{dt} = Q_{in} - Q_l$



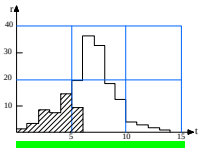
1.3 CONCEPTION DES PLUIES EXCESSIVES PAR METHODE D'ECOULEMENT

Perte initiale

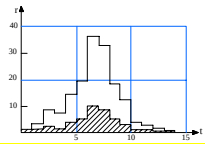
Excès de précipitations

Type d'hydrograph unitaire

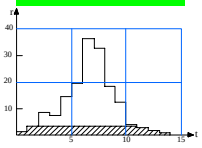
Type stockage



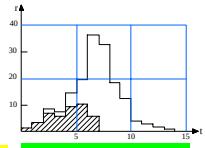
US SCS



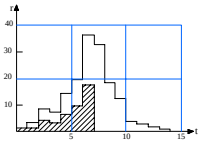
Marée kinematique



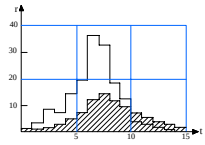
Marée kinematique



Nakayasu



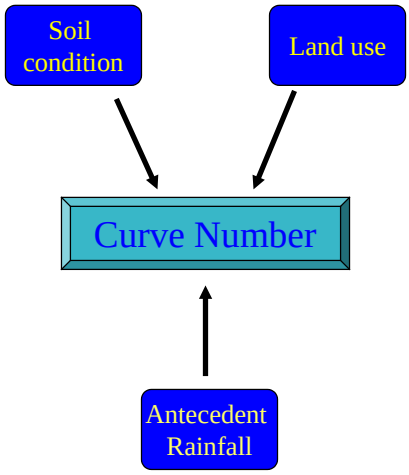
Fonction stockage



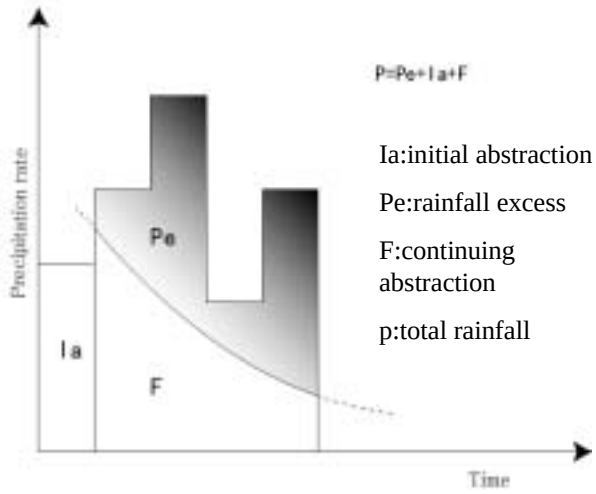
Modèle citèrne

1.4 Conception of SCS Method

- SCS (NRCS) developed
- Curve Number is express Runoff Characteristic
- Curve Number is decided from soil, land use, antecedent precipitation.
- SCS Unit Hydrograph Method is used for direct runoff



1.5 Conception of Excess Rainfall



Ia:initial abstraction

Pe:rainfall excess

F:continuing abstraction

p:total rainfall

1.6 Standard CN Number

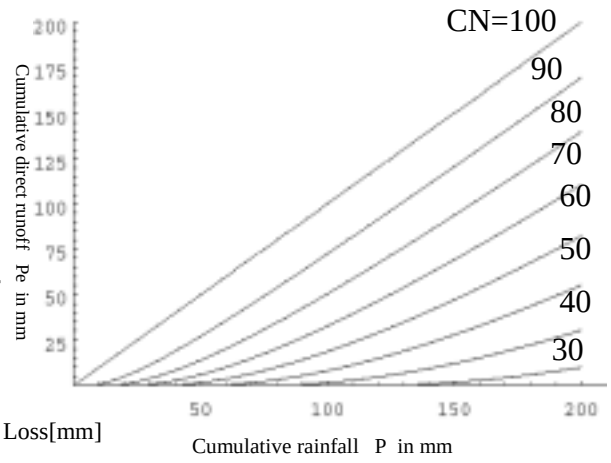
COVER DISCRIPTION		CN for Hydrologic Soil Groups			
Cover type and Hydrologic Condition	Average Percent Impervious	A	B	C	D
(a) Residential					
Average lot size					
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
(b) Paved Parking Lots, Driveways, etc.		98	98	98	98
(c)Streets and Roads					
Paved with curbs and storm sewers		98	98	98	98
Gravel		76	85	89	91
Dirt		72	82	87	89
(d) Commercial/Business Ares(85%Impervious)		89	92	94	95
(e) Industrial Districts(72%Impervious)		81	88	91	93
(f) Open spaces,Lawns,Parks,Golf Courses,Cemeteries etc					
Good condition :grass cover on > 75% of area		39	61	74	80
Fair condition:grass cover on 50 to 75% of area		49	69	79	84
Poor condition:grass cover < 50 of area		68	79	86	89

1.7 Difference of runoff by Curve Number

$$\frac{F}{S} = \frac{P_e}{P - I_a}$$

$$I_a = 0.2S$$

$$CN = \frac{1000}{10 + S/254}$$



P: Precipitation Ia: Initial Loss[mm]
F: Infiltration[mm]
Pe:Excess Rainfall [mm]
S: Saturation [mm]
CN:Curve Number

1.8 Flow Routing

Hydrograph (Upstream) → Hydrograph (Dowlstream)

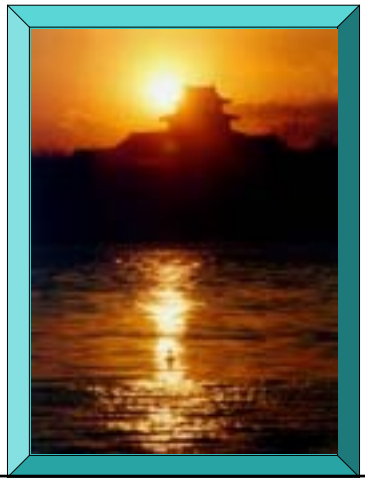
- Lumped Flow Routing (Hydrological Flow Routing)
  - Muskingum Method (River Routing)
  - Runge-Kutta Method (Level Pool Routing)
  - Storage Method River Type (River Routing)
- Distributed Flow Routing (Hydrodynamic Flow Routing)
  - Kinematic Wave Method
  - Diffusion Analog Method
  - Dynamic Wave Method

$$\frac{1}{g}\frac{\partial v}{\partial t} + \frac{v}{g}\frac{\partial v}{\partial t} + \frac{\partial t}{\partial x} - S_o - S_f = 0$$

2. Introduction of Hydraulic Model at Another Country

Chaophraya River Basin in Thailand

Tone River Basin in Japan



2.1 Tone River Basin

Extension of Rivers : 322km
Catchment Area : 16,840 km^2
Population : 11,630,000

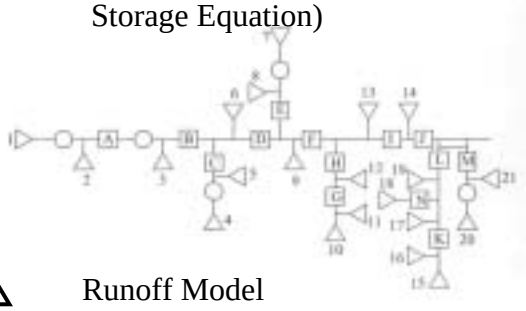
2.2 Model of Tone River Basin

Runoff Model

Storage Function Method

Flow Routing

Kinematic Wave (Use Storage Equation)

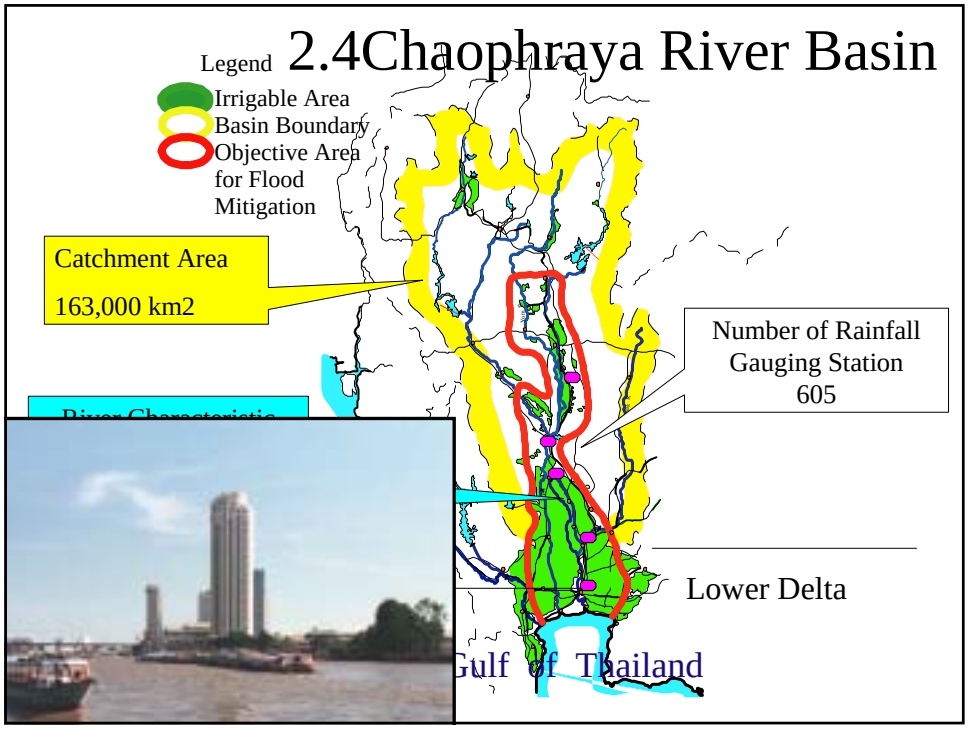


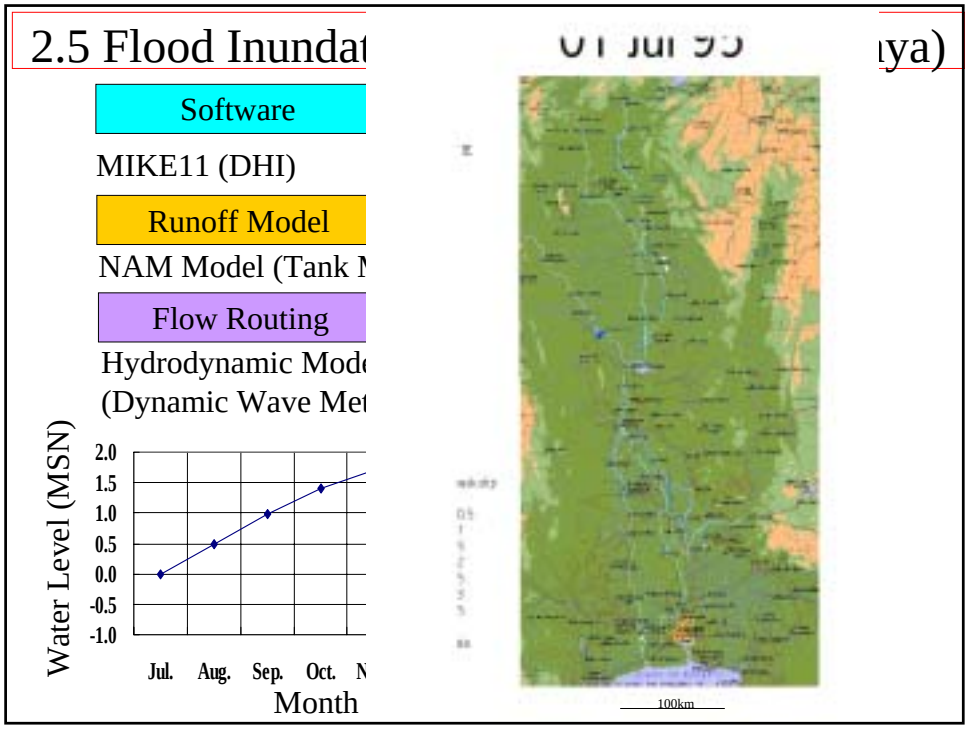
△ Runoff Model

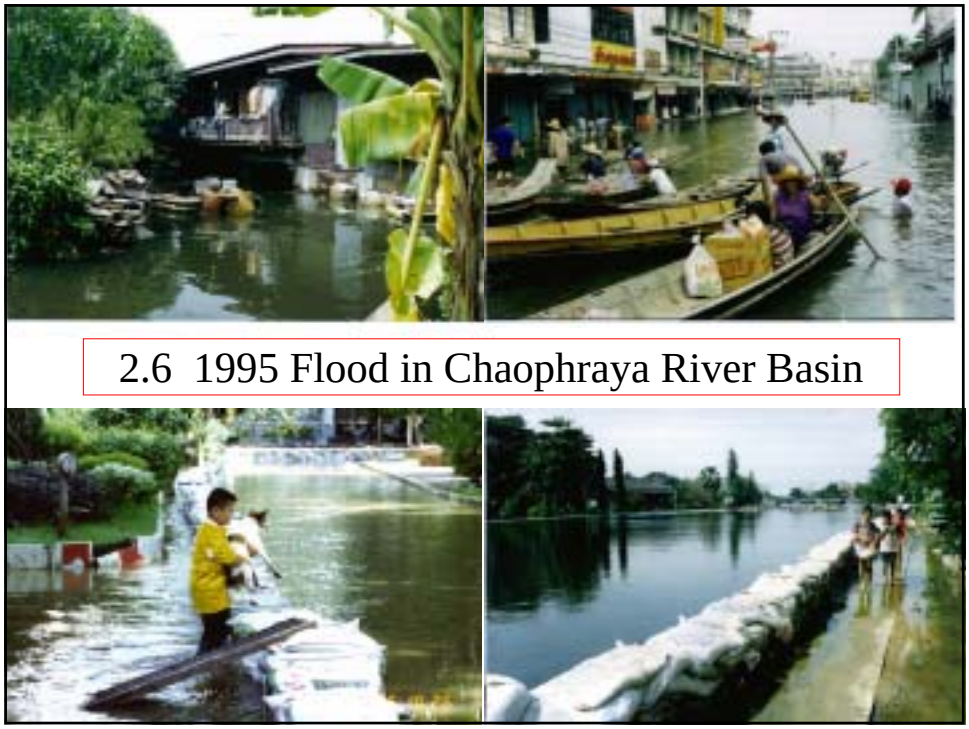
□ Flow Routing Model

2.3 Kingdum of Thailand

Source : Mekhong Region Development Network


2.4Chaophraya River Basin
Legend
Irrigable Area
Basin Boundary
Objective Area for Flood Mitigation
Catchment Area
163,000 km2
Number of Rainfall Gauging Station
605
Lower Delta
Gulf of Thailand

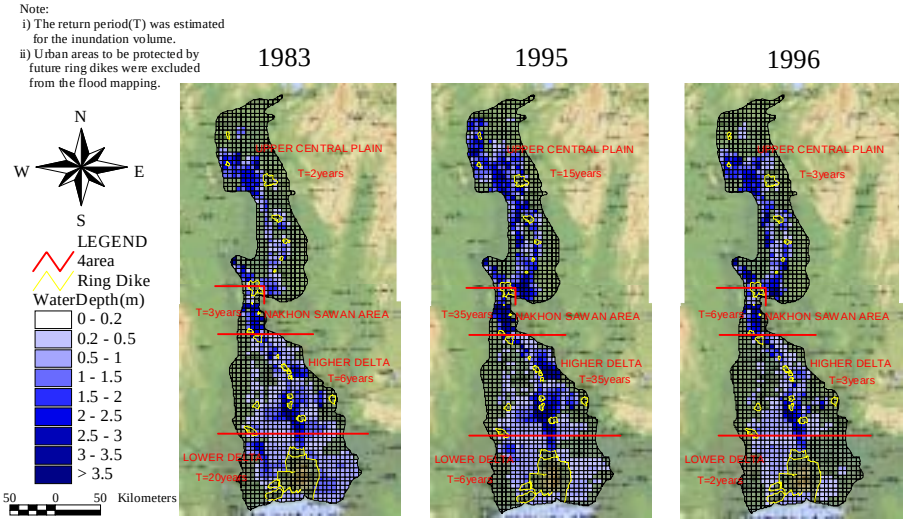

2.5 Flood Inundat
Software
MIKE11 (DHI)
Runoff Model
NAM Model (Tank
Flow Routing
Hydrodynamic Mod
(Dynamic Wave Met
Water Level (MSN)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
Jul.
Aug.
Sep.
Oct.
Month
100km



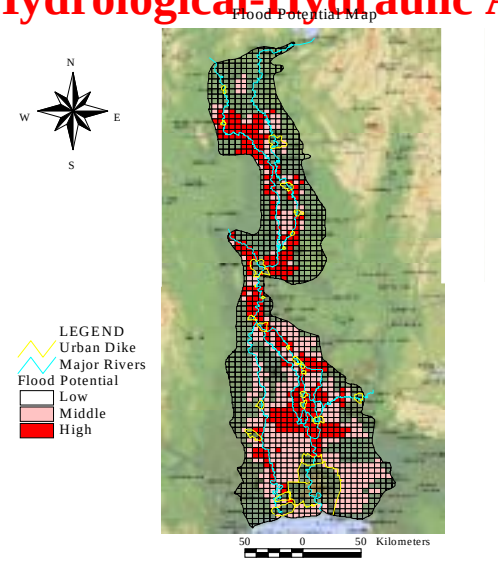
2.6 1995 Flood in Chaophraya River Basin

2.7 Flood Inundation Map (Historical Approach)

Note:
i) The return period(T) was estimated for the inundation volume.
ii) Urban areas to be protected by future ring dikes were excluded from the flood mapping.



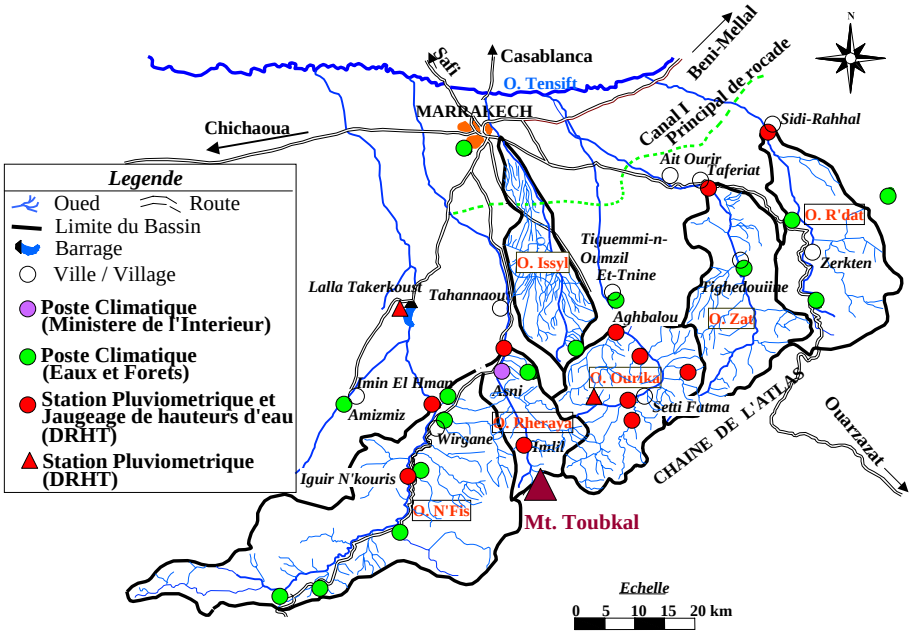
2.8 Flood Potential Map (Hydrological-Hydraulic Approach)



3. Characteristics of Rainfall

- for modeling of Study Area -

3.1 Availability of Hydrological Data

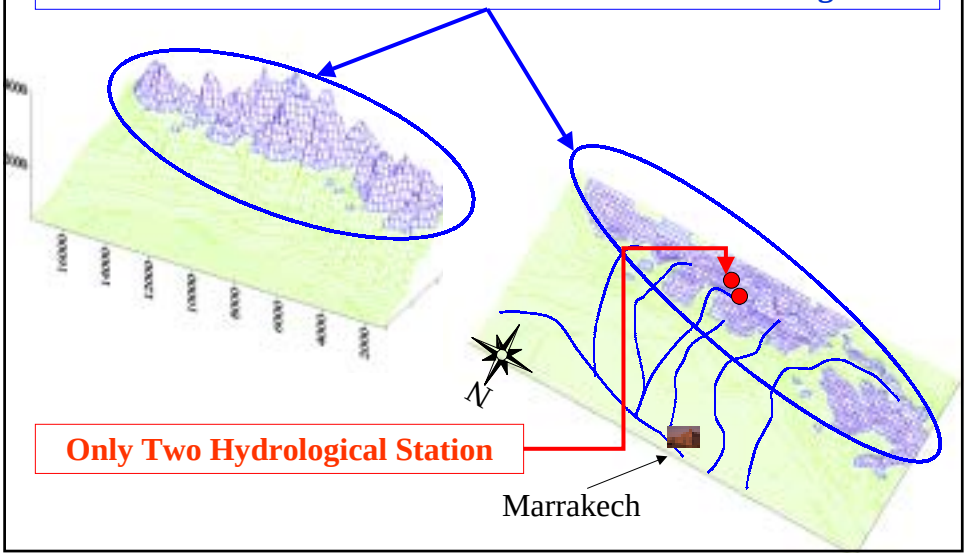


STATION DE JAUGEAGE DE PRECIPITATIONS POUR L'ETUDE HYROLOGIQUE

Bassin	N°	Nom de station	Administration	Emplacement		Installation	Altitude (m)	Période de données collectées
				Latitude	Longitude			
R'dat	1	Sidi Rahal	DRHT	31° 38.34	7° 28.52'	1963/10/3	690	1967-1999
	2	Azrif	WAF	31° 32'	7° 16'	01/01/51	1760	1951-1997
	3	Taddart	WAF	31° 21'	7° 25'	01/01/35	1650	1936-1997
	4	Toufliht	WAF	31° 28'	7° 26'	01/12/38	1465	1970-1997
Zat	5	Taferiat	DRHT	31° 32.80	7° 35.99'	1962/2/9	760	1980-1999
	6	Asloune	WAF	31° 24'	7° 32'	01/01/38	1115	1937-1997
Ourika	7	Aghbalau	DRHT	31° 19.02	7° 44.75'	1969/4/4	1070	1969-1999
	8	Agouns	DRHT	31° 11.98	7° 48.17'	1996/6/26	2200	1996-1999
	9	Tazzitount	DRHT	31° 16.44	7° 41.30'	1999/2/21	1270	1999
	10	Tourcht	DRHT	31.14.08	7.37.91	1997/12/4	1650	1970-1997
	11	Amenzal	DRHT	31° 11.28	7° 45.02'	1997/4/10	2230	1997-1999
	12	Tiourdiou	DRHT	31° 12.02	7° 44.78'	1996/6/20	1850	1996-1999
Rheraya	13	Tahanaout	DRHT	31° 17.66	7° 57.85'	1962/3/8	925	1962-1999
	14	Armed	DRHT	31° 07'	7° 55'	1999/2/12	1950	1999
	15	Ifghane	WAF	31° 14'	7° 55'	01/09/73	1920	1977-1999
	16	Asni	MOF	31° 15'	8° 00'	01/01/37	1200	1937-1997
N'fis	17	Imin El Hamman	DRHT	31° 12.87	8° 06.72'	1966/7/1	770	1969-1999
	18	Iguir N'kouris	DRHT	31° 03.54	8° 08.38'	1974/3/20	1100	1974-1999
	19	Arhbar	WAF	30° 52'	8° 24'	01/04/37	1900	1938-1997
	20	Idni	WAF	30° 55'	8° 17'	24/04/53	1700	1953-1997
	21	Ijoukak	WAF	31° 01'	8° 09'	01/02/42	1440	1941-1997
	22	Ourigane	WAF	31° 09'	8° 07'	02/27/89	1045	1989-1998
	23	Talat Nos	WAF	31° 03'	8° 08'	01/04/37	1300	1937-1997
Autres	24	B.L.Takerkoust	DRHT	31° 21.47	8° 08.38'	1962	630	1953-1999
	25	Agaiouar	WAF	31° 17'	7° 49'	04/25/89	1805	1930-1997
	26	Dar Ouriki	WAF	31° 22'	7° 47'	01/06/37	800	1937-1997
	27	Tizi Ghourane	WAF	31° 13'	8° 14'	01/01/36	1150	1970-1997
	28	Amizmiz	WAF	31° 13'	8° 14'	06/01/23	1005	1923-1995
	29	Marrakech	DMN	31° 36'	8° 01'	01/01/84	460	1913-1999

3.2 Topography of Study Area and Distribution of Hydrological Station

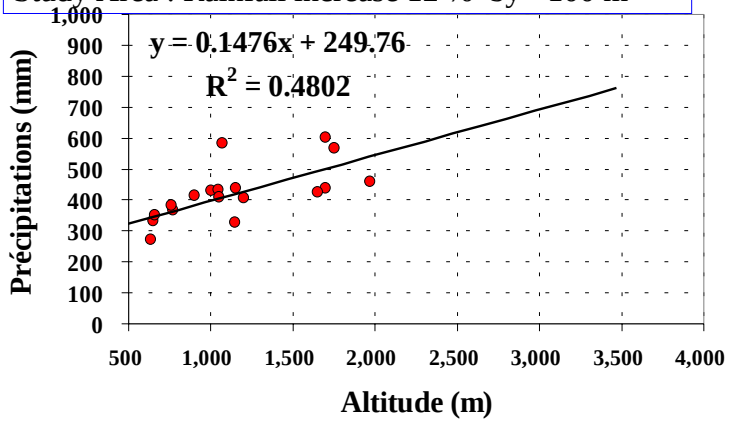
Area over the elevation of 2000m is 60 % at Atlas Region



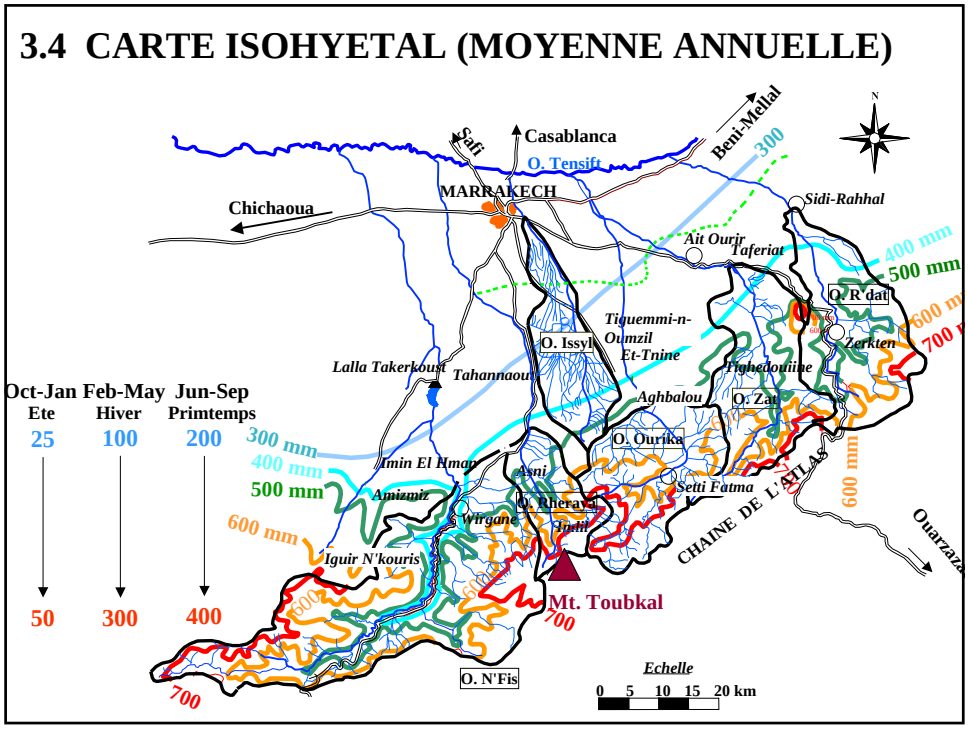
3.3 Corrélation Précipitation-Altitudes dans la Zone d'Etude

Japan : Rainfall increase 5 – 10 % by +100 m

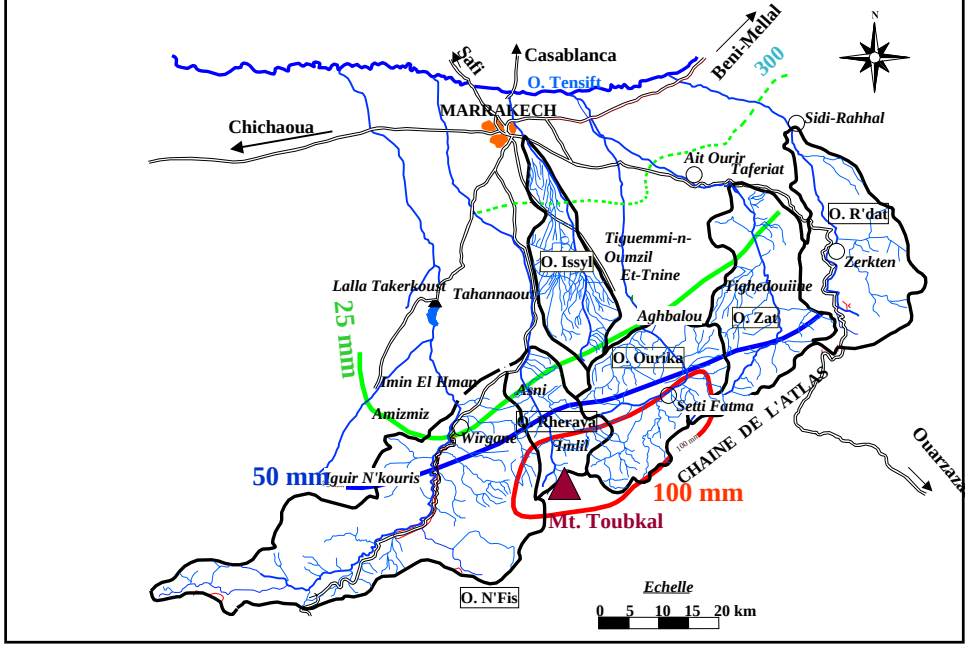
Study Area : Rainfall increase 12 % by +100 m



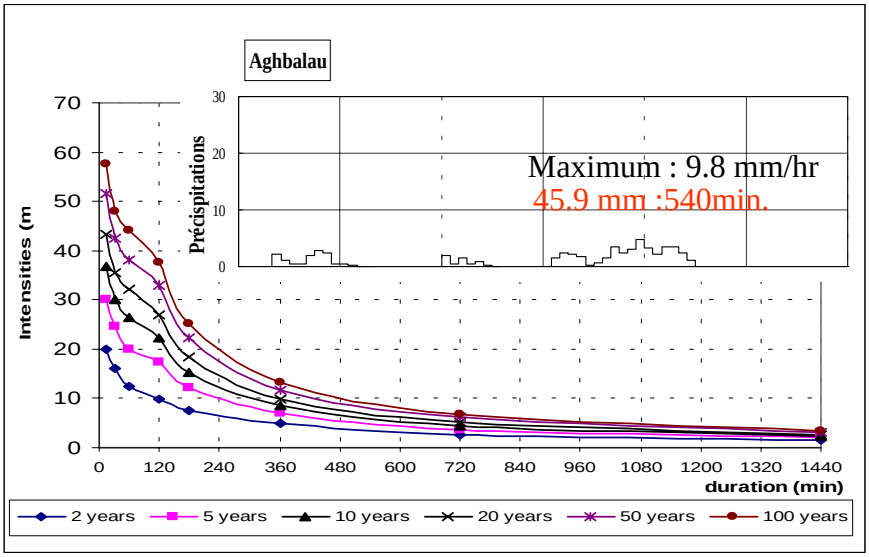
3.4 CARTE ISOHYETAL (MOYENNE ANNUELLE)



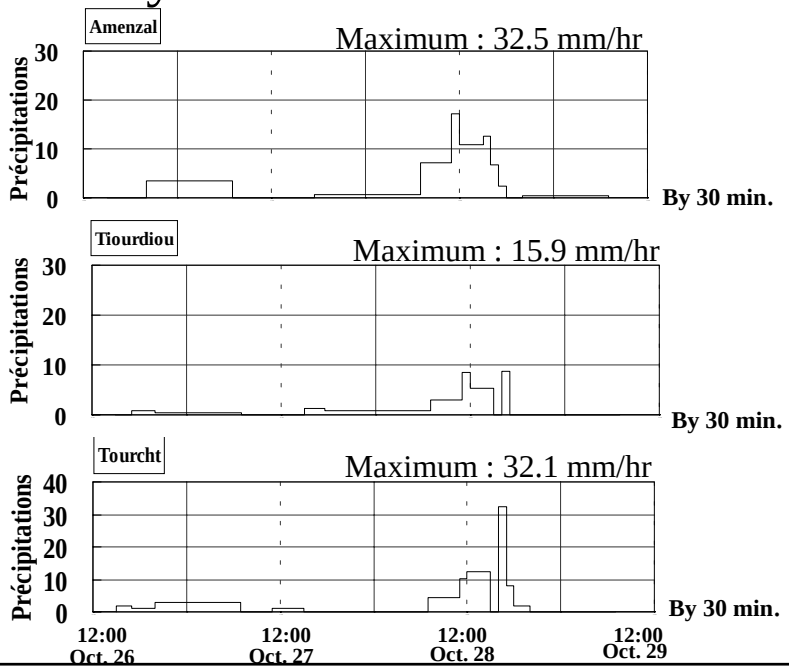
3.5 Distribution of Rainfall 1999 Flood



3.6 Corrélation intensité - durée - fréquence

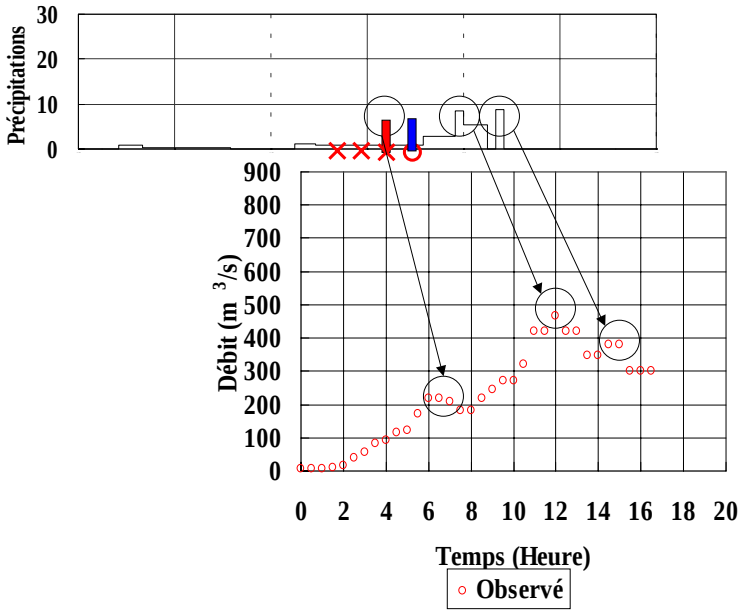


3.7 Hourly Rainfall in 1999 Flood



3.8 Observed Hydrograph in 1999

- Tiourdiou -



4. Establish of Flood Simulation Model

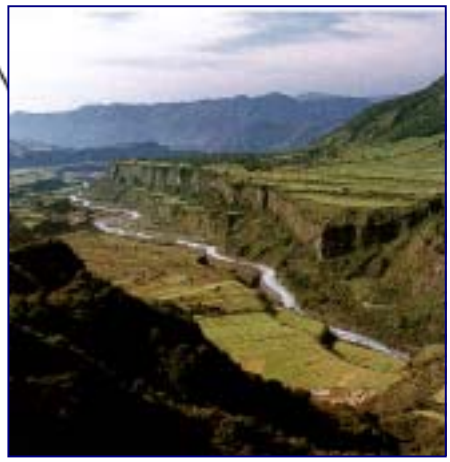
Objective

1. To identify probable flood inundation area

2. To determine basic hydrological parameters for flood forecasting

4.1 Characteristic of Rivers

N’fis, Rheraya, Ourika, R’dat, and Zat River



Issyl River

4.2 Sélection du logiciel

Logiciel sélectionné pour l'analyse des inondations

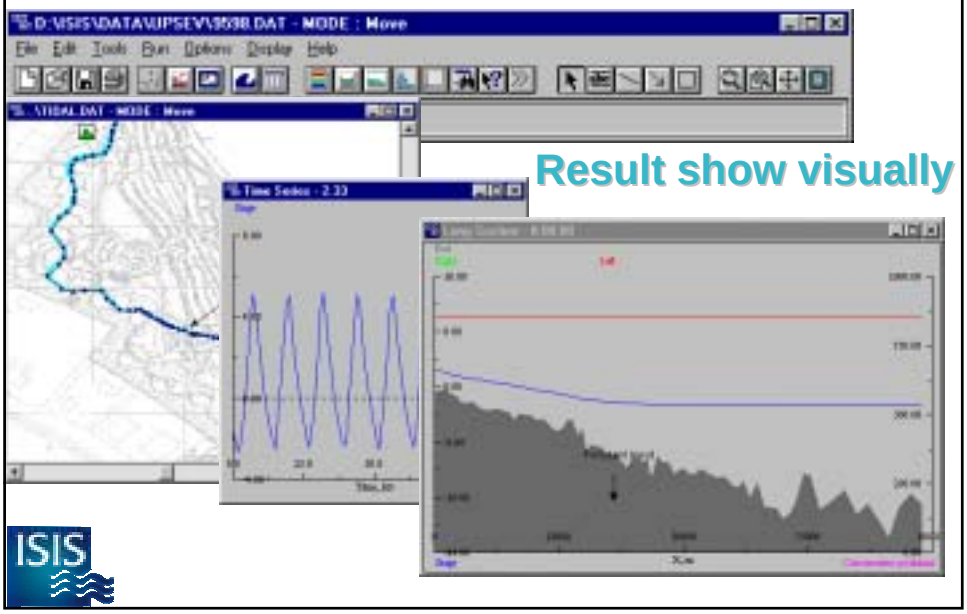
Oued	Type d'inondation	Logiciel proposé
5 oueds autres que l'Issyl	Limité dans la vallée	ISIS (Modèle d'écoulement dynamique unidimensionnel)
Oued Issyl	Déversant dans la plaine	Modèle d'écoulement dynamique bidimensionnel

4.3 ISIS Software Package

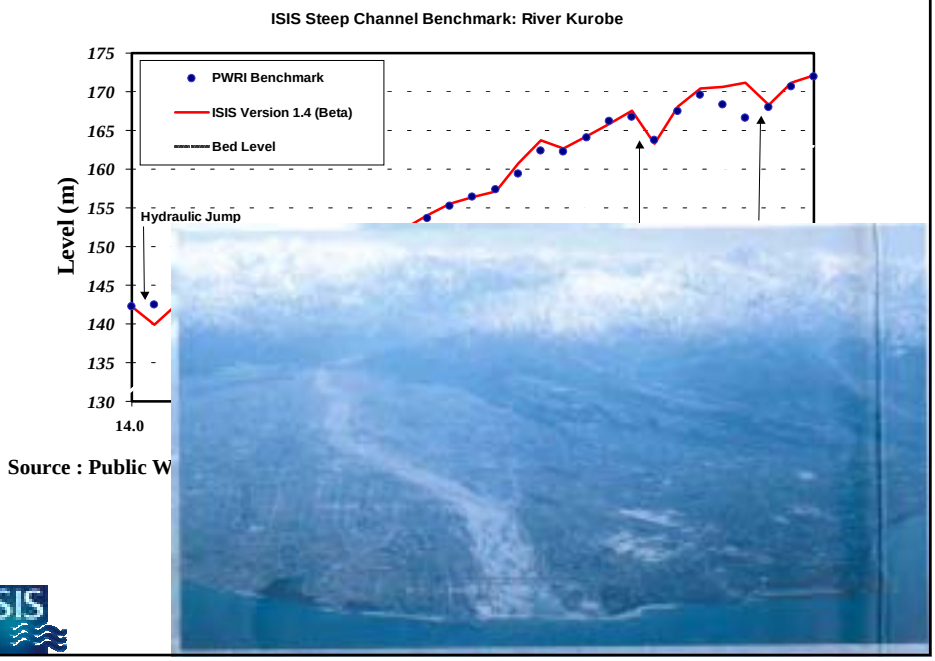
•ISIS is a package software supplied by HR Wallingfort in England
•ISIS is suitable for a wide range of river engineering and environmental

Module disponible	Contenu du module	Usage dan l'Etude
ISIS Flow	Modelage hydrodynamique du système de canalisation ouverte et convertie.	Oui
ISIS Steady	Calcul de retour, y compris les écoulements trans-critiques	Oui
ISIS Routing	Déroutement des crues	Oui
ISIS Hydrology	Modelage des écoulements des eaux de pluies	Oui
ISIS Quality	Modelage de traitement de la qualité d'eau	Non
ISIS Sediment	Modelage des transports de sédiment	Non
ISIS WMS	Module de cartographie (zone inondable)	Oui

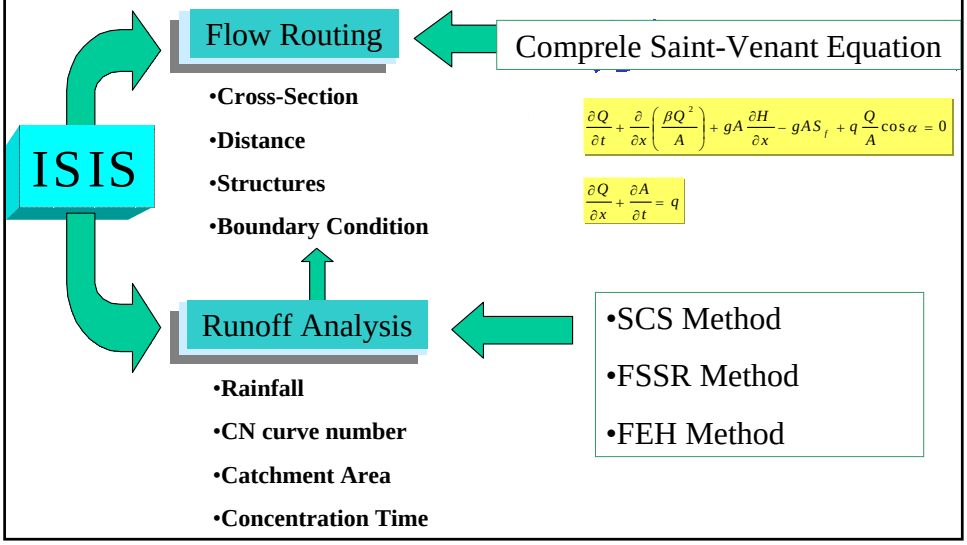
4.4 Display of ISIS Software



4.5 Simulation Result of Kurobe River in Japan



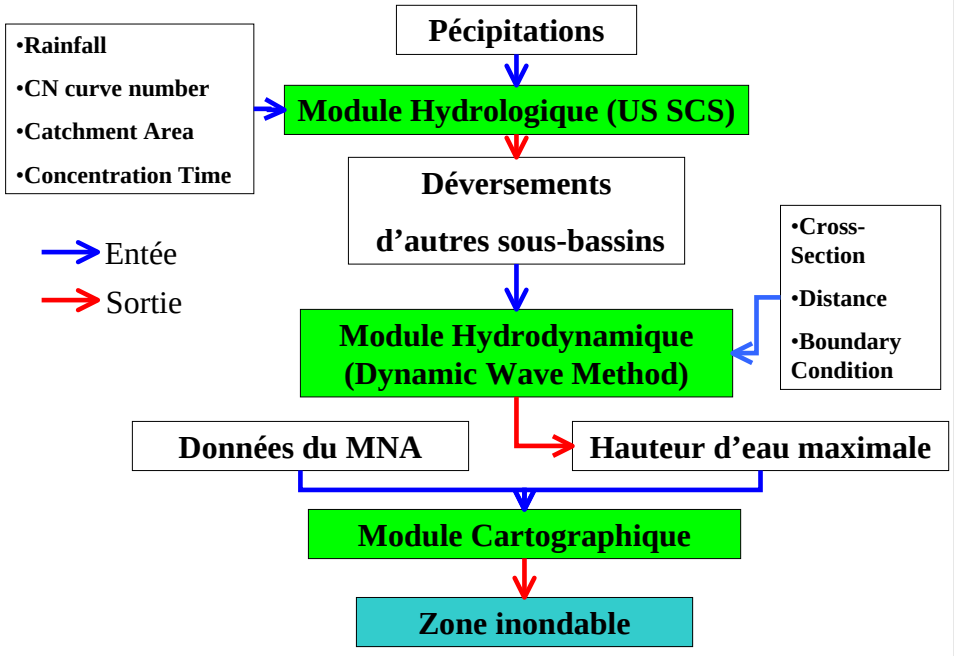
4.6 Contents ISIS FLOW



4.7 Hydrological Unit

- ABSTRACTION
- BERNOULLI LOSS
- BOUDARIES
  - Flow-Stage Boundary
  - Flow-Time Boundary
  - Head-Time Boundary
  - Tidal Harmonics Boundary
- BRIDGES
  - Arch Bridge
  - USBPR Bridge
- CONDUITS
  - Circular Conduit
  - Full Arch Conduit
  - Irregular Symmetrical Section
  - Rectangular Conduit
- HYDROLOGICAL BOUNDARIES
  - Flood Studies Supplementary Report 16 Method
  - Soil Conservation Service Method
- INTERPOLATE
- JUNCTION
- ORIFICE
  - Orifice
  - Inverted Syphon
  - Outfall
  - Flood Relief Arch
- PUMP
- RATING CURVE
- REPLICATE
- RESERVOIR
- RIVER
  - River Unit
  - Muskingum Routing
  - Variable Parameter Muskingum Cunge Routing
  - VPMC Cross Section
- SPILL
- WEIRS
  - Crump Weir
  - Gated Weir
  - Notional Weir
  - Flow-Head Control
  - Sharp Crested Weir
  - Syphon Spillway
  - General Purpose Weir

4.8 Structure du modèle

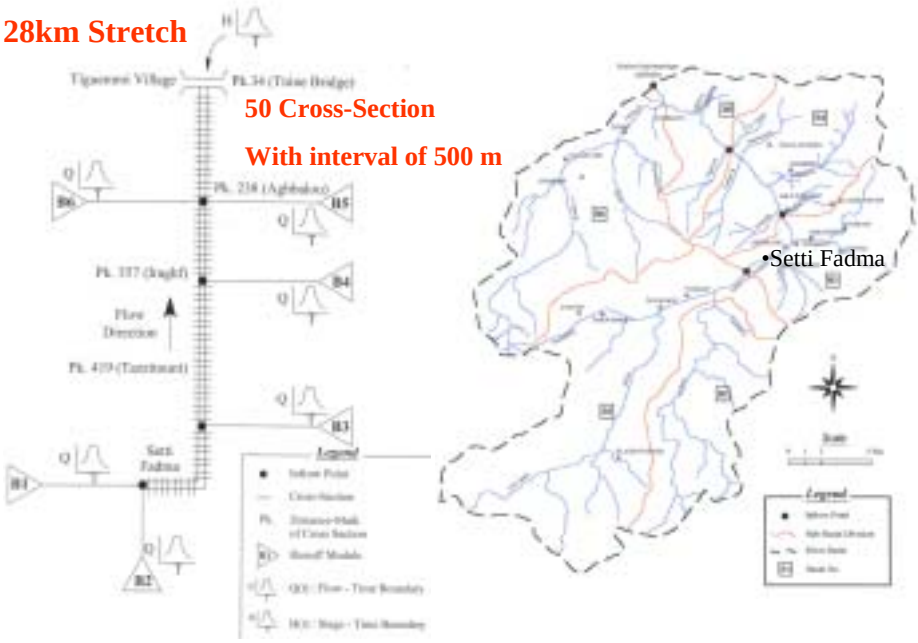


4.9 Schematic Diagram of Simulation Model

28km Stretch

50 Cross-Section

With interval of 500 m



4.10 Calibrage du modèle

•Crues cibles

•La crue du 18 aout 1995

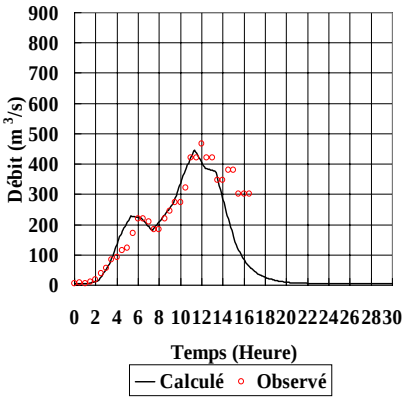
Most hydrological records are available among the past Major flood

•Problems

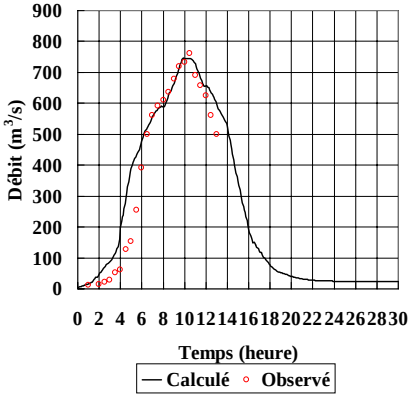
•Insufficient of Hydrological data (especially Rainfall)

4.11 Résultats du calibrage

Tiourdiou

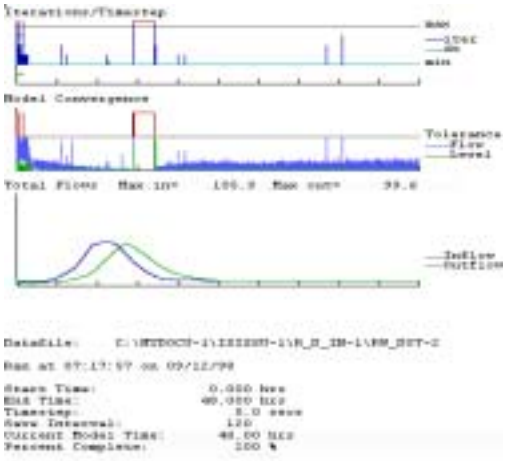


Aghbalau

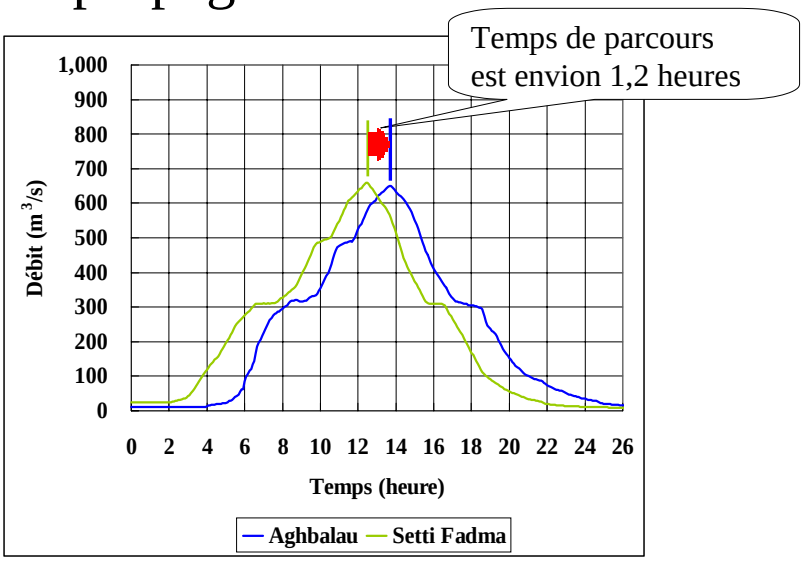


4.12 Cartographie des crues

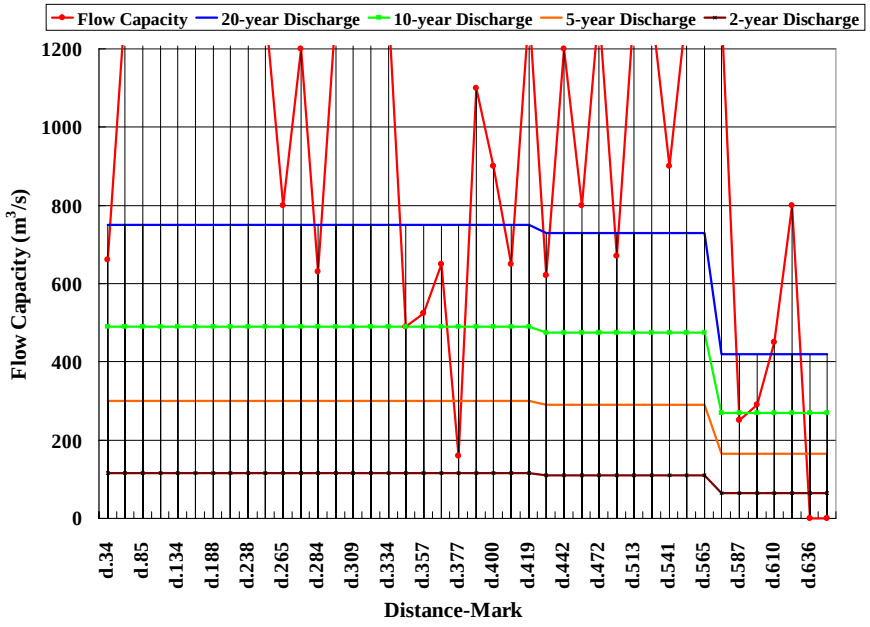
5. ETUDES HYDRAULIQUES PAR MODÈLE CALIBRÉ



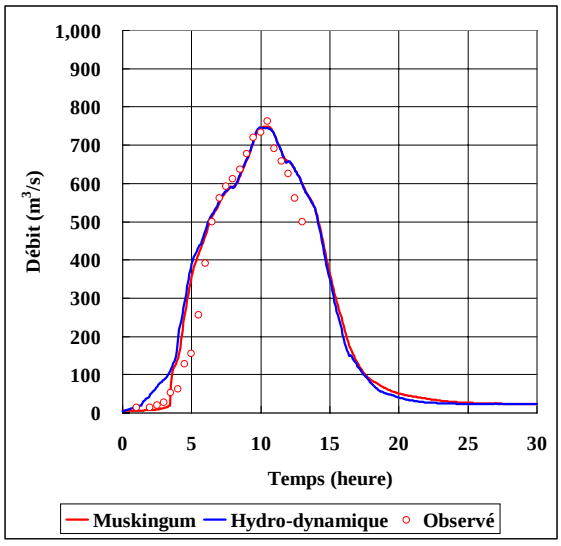
5.1 Estimation de la vitesse de propagation des crues



5.2 Estimation of Flow Capacity



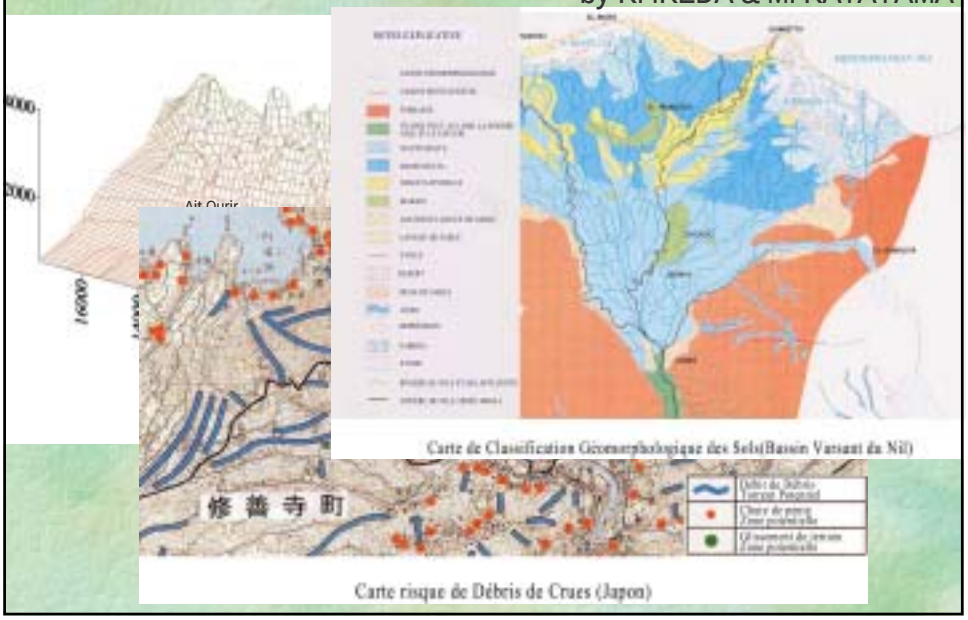
5.3 Etudes hydrauliques par modèle calibré




CONCLUSION

GEO-MORPHOLOGICAL ANALYSIS

by K. IKEDA & M. KATAYAMA



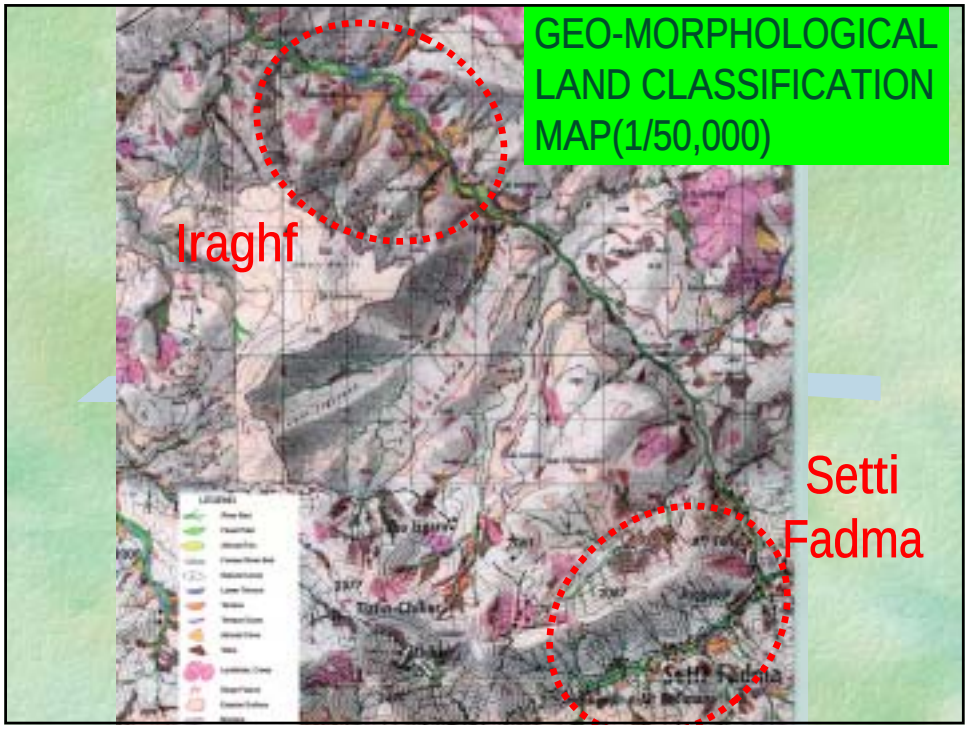
Carte de Classification Géomorphologique des Sols(Bassin Versant du Nil)

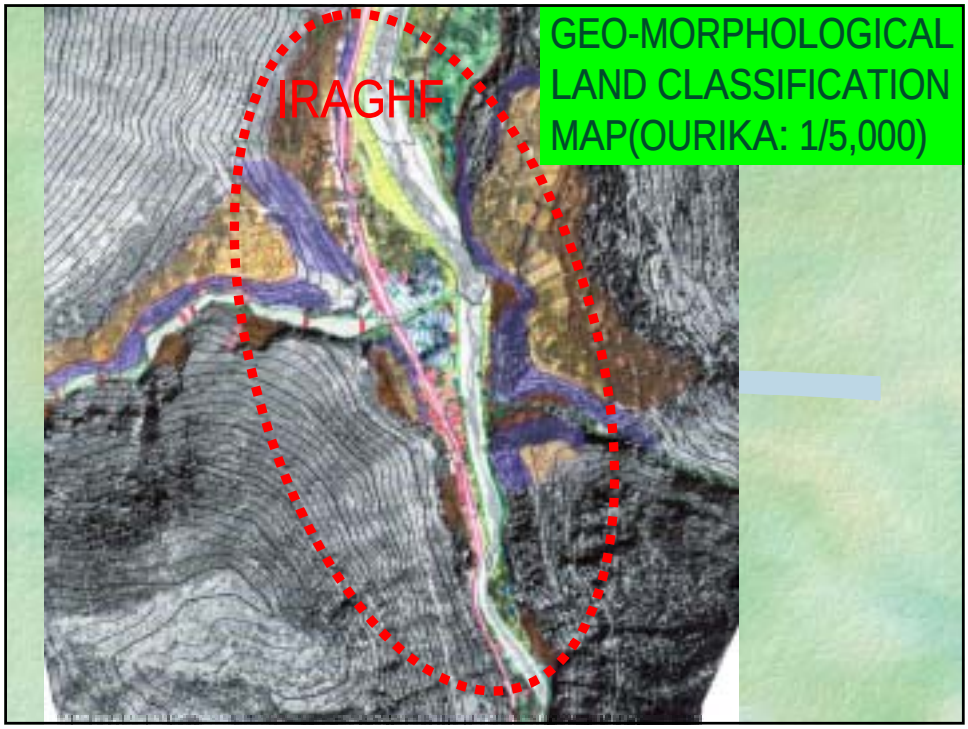
Carte risque de Débris de Crues (Japon)

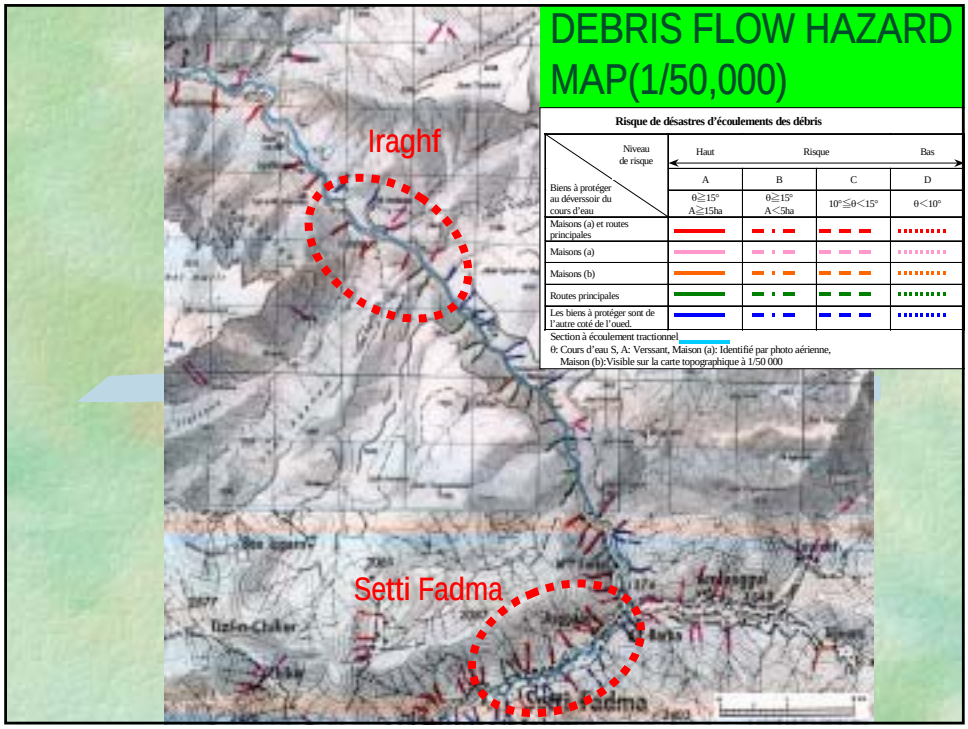
PURPOSE OF GEO-MORPHOLOGICAL ANALYSIS

- *Preparation of Geo-morphological Land Classification Map*
  - *Historical Interpretation of Land Form*
  - *Identification of Disaster Potential Areas*

- *Preparation of Debris Flow Hazard Map*
  - *Identification of Potential Debris Flow Disaster Streams*
  - *Utilization of Debris Flow Hazard Map for Preparation of Evacuation Plan, Land Use Control and Guidance*


GEO-MORPHOLOGICAL
LAND CLASSIFICATION
MAP(1/50,000)
Iraghf
Setti
Fadma


GEO-MORPHOLOGICAL
LAND CLASSIFICATION
MAP(OURIKA: 1/5,000)
IRAGHF


DEBRIS FLOW HAZARD MAP(1/50,000)
Iraghf
Setti Fadma
Risque de désastres d'écoulements des débris
Niveau de risque
Haut
Risque
Bas
Biens à protéger au déversoir du cours d'eau
A
B
C
D
θ≧15° A≧15ha
θ≧15° A<5ha
10°≦θ<15°
θ<10°
Maisons (a) et routes principales
Maisons (a)
Maisons (b)
Routes principales
Les biens à protéger sont de l'autre coté de l'oued.
Section à écoulement tractionnel
θ: Cours d'eau S, A: Verssant, Maison (a): Identifié par photo aérienne,
Maison (b):Visible sur la carte topographique à 1/50 000

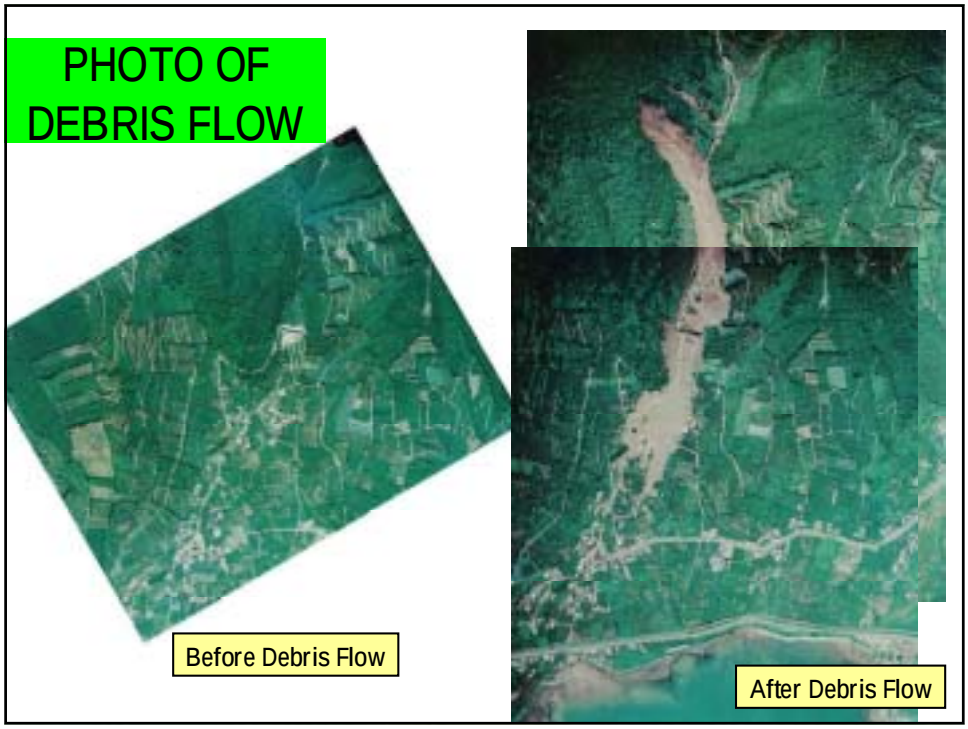


PHOTO OF DEBRIS FLOW
Before Debris Flow
After Debris Flow