Water and Disasters: Challenges and Opportunities

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The University of Western Ontario

Summary of 2004

Began	Ended	Country	Main cause	Affected Region (km²)	Dead	Displaced	Damage (US $)
01/10/04	01/11/04	Boliva	Heavy rain	3,570		40,000	
01/10/04	03/08/04	Brazil	Heavy rain	2,019,000	161	230,000	$117,000,000
01/14/04	02/25/04	Australia	Monsoonal rain	1,232,000		3,400	$32,000,000
01/24/04	02/03/04	Malaysia	Heavy rain	32,620	3	6,900	
02/01/04	06/02/04	Namibia, Zambia, Angola and Botswana	Heavy rain	596,100	10	40,000	
02/13/04	02/25/04	New Zealand	Heavy rain	14,840	2	2,500	$210,000,000
02/18/04	02/23/04	Indonesia	Heavy rain	280	5	13,000	$60,000,000
03/05/04	03/09/04	Papua New Guinea	Heavy rain	2,000		10,000	
03/06/04	03/08/04	Brazil	Heavy rain	2,880	4	60,000	
03/07/04	03/19/04	Madagascar	Tropical cyclone	44,230	198	216,000	$250,000,000
03/28/04	04/11/04	USA and Canada	Rain and snowmelt	30,760		1,000	$4,500,000
04/08/04	04/18/04	Fiji	Tropical cyclone	9,450	10	2,760	$2,600,000
04/09/04	05/11/04	Kenya	Heavy rain	268,300	50	15,000	
04/12/04	05/02/04	Bosnia-Herzegovina, Croatia and Romania	Heavy rain	105,000		1,200	$15,200,000
04/14/04	05/03/04	Bangladesh and India	Heavy rain	29,070	12	50,000	
04/14/04	05/16/04	Russia	Rain and snowmelt	264,500	18	4,800	$25,000,000
05/13/04	05/17/04	China	Heavy rain	10,940	7		$53,500,000

Summary of 2004 – cont.

05/22/04	05/26/04	USA	Heavy rain	117,300	1	150	$32,000,000
05/23/04	06/01/04	Dominican Republic, Haiti and Puerto Rico	Heavy rain	8,900	3,300	13,000	
06/03/04	10/11/04	USA	Dam/Levy, break or release	600	0	300	$20,000,000
06/12/04	06/15/04	Mexico	Heavy rain	420	1	350	$3,600,000
06/20/04	06/25/04	China	Heavy rain	92,250	27	168,000	$360,000,000
06/20/04	10/07/04	India, Bangladesh and Burma	Monsoonal rain	1,163,000	3,000	40,000,000	
06/24/04	07/20/04	Nicaragua	Heavy rain	26,960	25	18,000	$11,200,000
06/29/04	07/13/04	Philippines, Taiwan and North Korea	Tropical cyclone	84,820	54	385,000	$60,000,000
06/30/04	07/01/04	Chile	Heavy rain	4,600	3	9,000	
07/04/04	07/23/04	China	Heavy rain	44,800	35	26,000	
07/05/04	08/11/04	Nepal and Bhutan	Monsoonal rain	65,220	185	100,000	
07/12/04	07/15/04	USA	Heavy rain	2,440		500	$30,000,000
07/14/04	07/27/04	China	Heavy rain	156,600	24	82,000	
07/15/04	07/17/04	Canada	Brief torrential rain	510		250	$40,000,000
07/15/04	07/25/04	South and North Korea	Monsoonal rain	102,900	34	160,000	
07/16/04	07/30/04	China	Heavy rain	52,800		150,000	
07/17/04	07/30/04	China	Heavy rain	86,020	2	135,000	$51,200,000
07/18/04	07/28/04	Vietnam	Heavy rain	12,020	36		$8,300,000
07/28/04	08/02/04	Romania	Heavy rain	17,940	8	2,000	$40,000,000
07/28/04	07/31/04	USA	Heavy rain	21,190	3		$17,000,000

Summary of 2004 – cont.

07/31/04	08/13/04	Philippines	Heavy rain	2,440		80,000	
08/01/04	09/08/04	India and Pakistan	Monsoonal rain	638,400	210	100,000	
08/06/04	10/03/04	Thailand	Monsoonal rain	154,400	11	60,000	
08/07/04	08/09/04	South Africa	Heavy rain	199		15,000	
08/08/04	08/10/04	Nigeria	Heavy rain	510		15,000	
			Tropical cyclone	16,660	164	30,000	$2,200,000,000
			Heavy rain	141		150	$1,000,000,000
08/24/04	09/12/04	Philippines and Taiwan	Tropical cyclone	38,800	67	1,058,849	$23,500,000
08/24/04	10/21/04	Vietnam and Cambodia	Monsoonal rain	47,460	34	30,000	
08/30/04	08/31/04			2,660	13	5,900	$124,000,000
08/30/04	09/01/04			0,710	7		$62,000,000
09/03/04	09/09/04	China	Heavy rain	72,280	196	500,000	$470,000,000
09/08/04	09/21/04	Caribbean and USA	Tropical cyclone	363,500	100	20,000	
09/15/04	10/01/04	Caribbean and USA					
09/17/04	09/19/04	Panama					
10/07/04	10/18/04	India and Bangladesh	Heavy rain	161,700	210	100,000	
10/07/04	11/04/04	Togo	Heavy rain	110		300	
10/11/04	11/22/04	Colombia	Heavy rain	159,600	19	187,900	
10/20/04	10/24/04	Japan	Tropical cyclone	32,210	83	42,000	
12/10/03	01/23/04	Indonesia	Heavy rain	79,400	148	350,000	
12/19/03	01/07/04	Philippines	Heavy rain	12,920	200	97,500	$3,000,000
					11,699	44,930,409	5,325,600,000

11,699 dead

45 million displaced

US $ 5.3 Billion in damages

Presentation outline

- Challenges
- Opportunities
  - One view of the future
- Workshop – on the way to Kobe
- ICLR priority
- Conclusions
- Review of 2004 in Canada

January, 2004 ; Laval area flooding

January, 2004 ; Laval area flooding

January, 2004 ; Laval area flooding

Challenges

- How to reduce the loss of life and property damage and in the same time obtain the social, environmental and economic benefits from the floodplains.
  - Urban areas
  - Rural areas

Challenges

- How to develop area-specific adaptation strategies
  - Living with water-related disasters
  - Capacity building
  - Local knowledge
  - Participation of all stakeholders

Challenges

- How to improve our knowledge base
  - Prediction of hazardous events
  - Assessment of risk and vulnerability
  - Integrated use of structural and non-structural protection measures
  - Enhancement of preparedness
  - Evaluation of impacts
  - Knowledge sharing
  - Climate change impacts

Challenges

- How to take advantage of the new technologies
  - Monitoring hazardous events
  - Data sharing

Challenges

- How to implement interdisciplinary approach
  - Disciplinary thinking
  - Educational barriers
  - Lack of funding

Challenges

- How to find appropriate financial mechanisms for those in need
  - National policy
  - International assistance

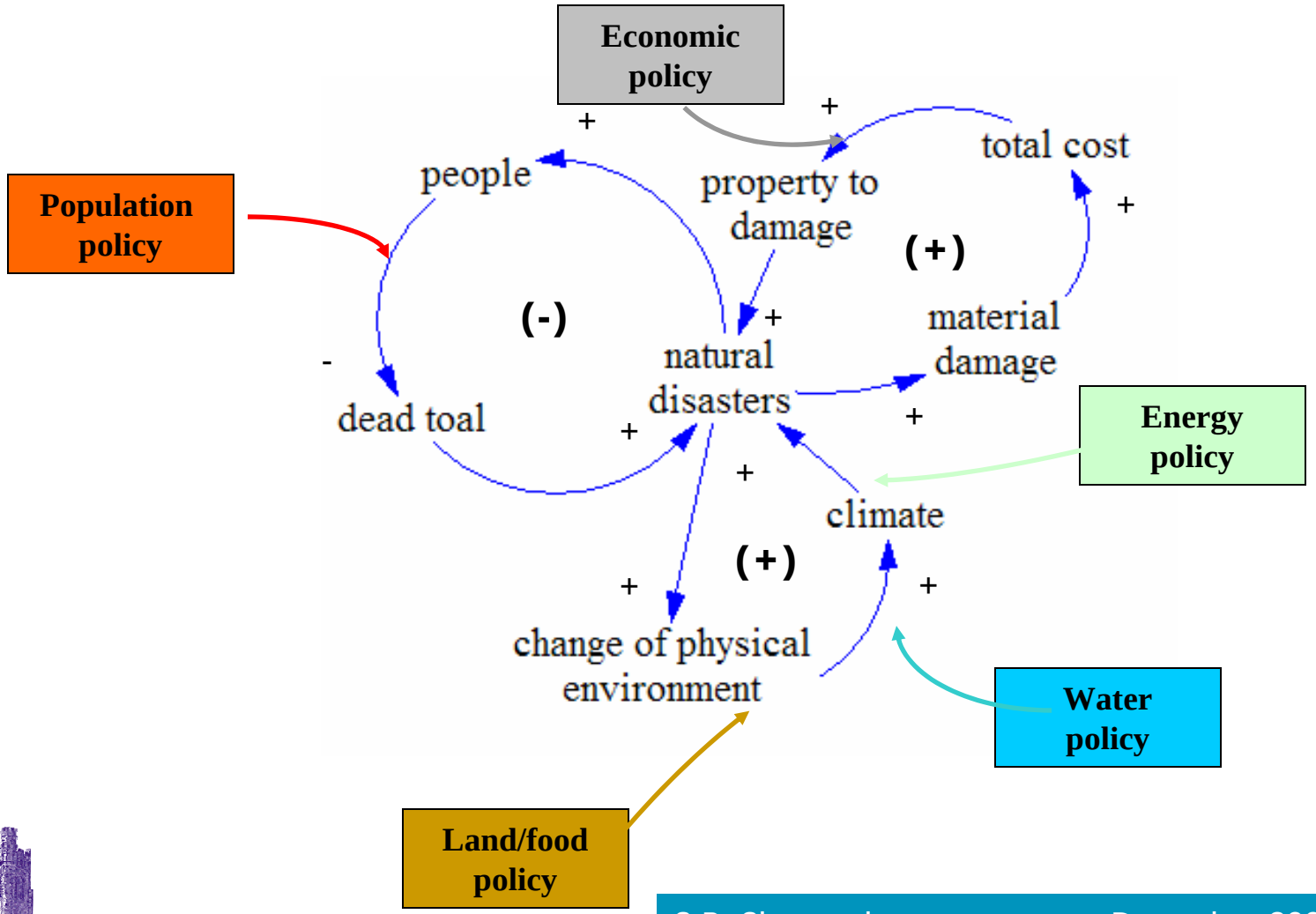
January, 2004 ; New Brunswick and PEI storm surges

January, 2004 ; New Brunswick and PEI storm surges

Opportunities

- Systems approach to water-related disasters analyses
  - Systems approach deals with theories about the behaviour of entities which exhibit organised complexity.
  - Systems analysis - the use of rigorous methods to help determine preferred plans and designs for complex, often large-scale systems.
  - Systems approach combines:
    - knowledge of the available analytic tools,
    - understanding of when each is more appropriate, and
    - skill in applying them to practical problems.

Systems approach



Systems approach

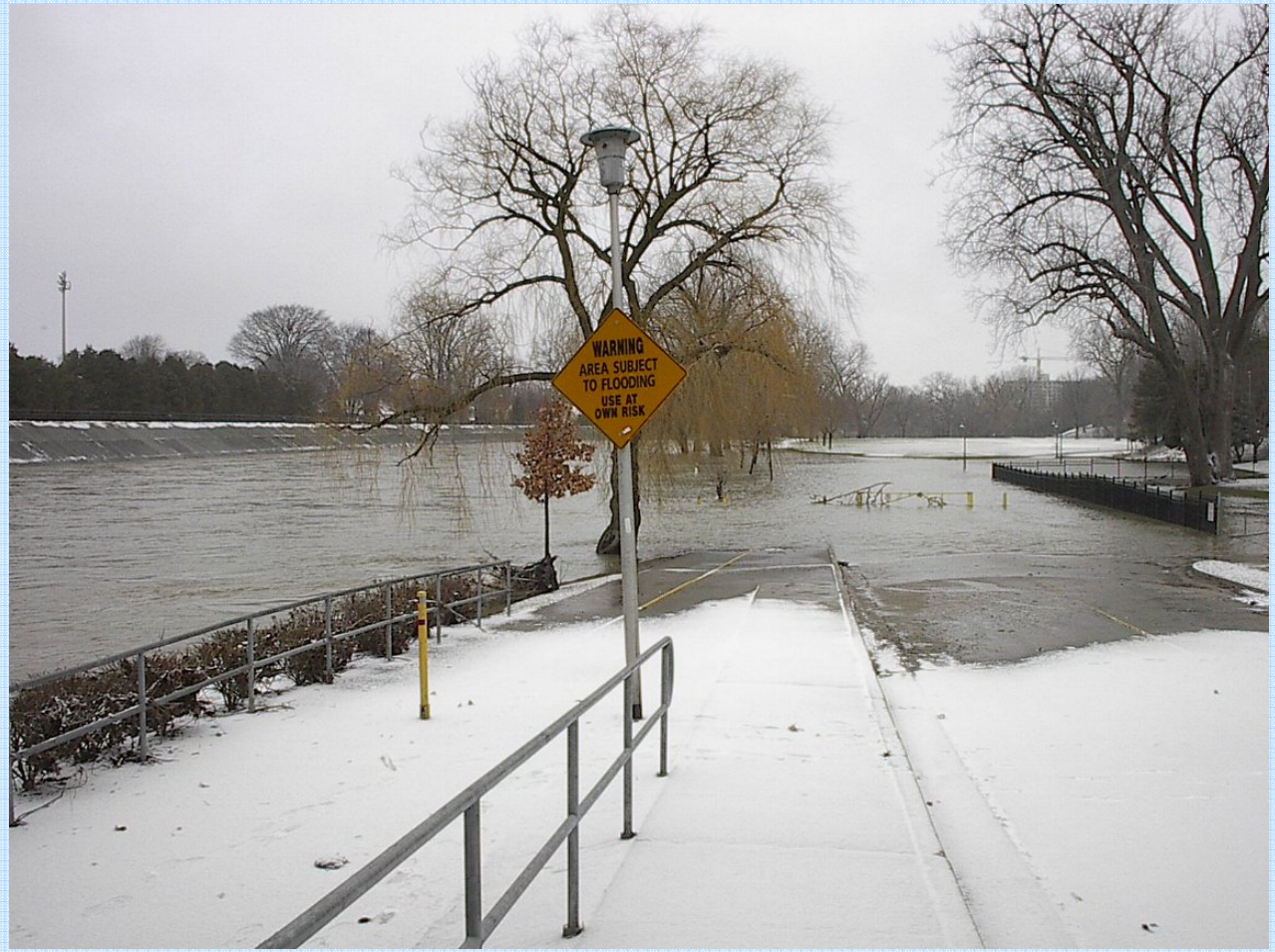
- Mathematical models:
  - Simulation
  - Optimization
  - Multi-objective analysis
- Functions of mathematical models:
  - Amplification
  - Organization
  - Evaluation

Systems approach

- Network flow problems
  - Optimal evacuation routes
- Optimal allocation of resources
  - Emergency management
  - Planning disaster mitigation measures
- Optimal scheduling
  - Budget distribution
  - Emergency management tasks
- Optimal sizing
  - Design of structural measures
  - Operation of storage facilities
- Simulation
  - Evacuation
  - Operating policies for protection structures

March, 2004 ; London flood threat

March, 2004 ; London flood threat



March, 2004 ; London flood threat

March, 2004 ; London flood threat

Opportunities

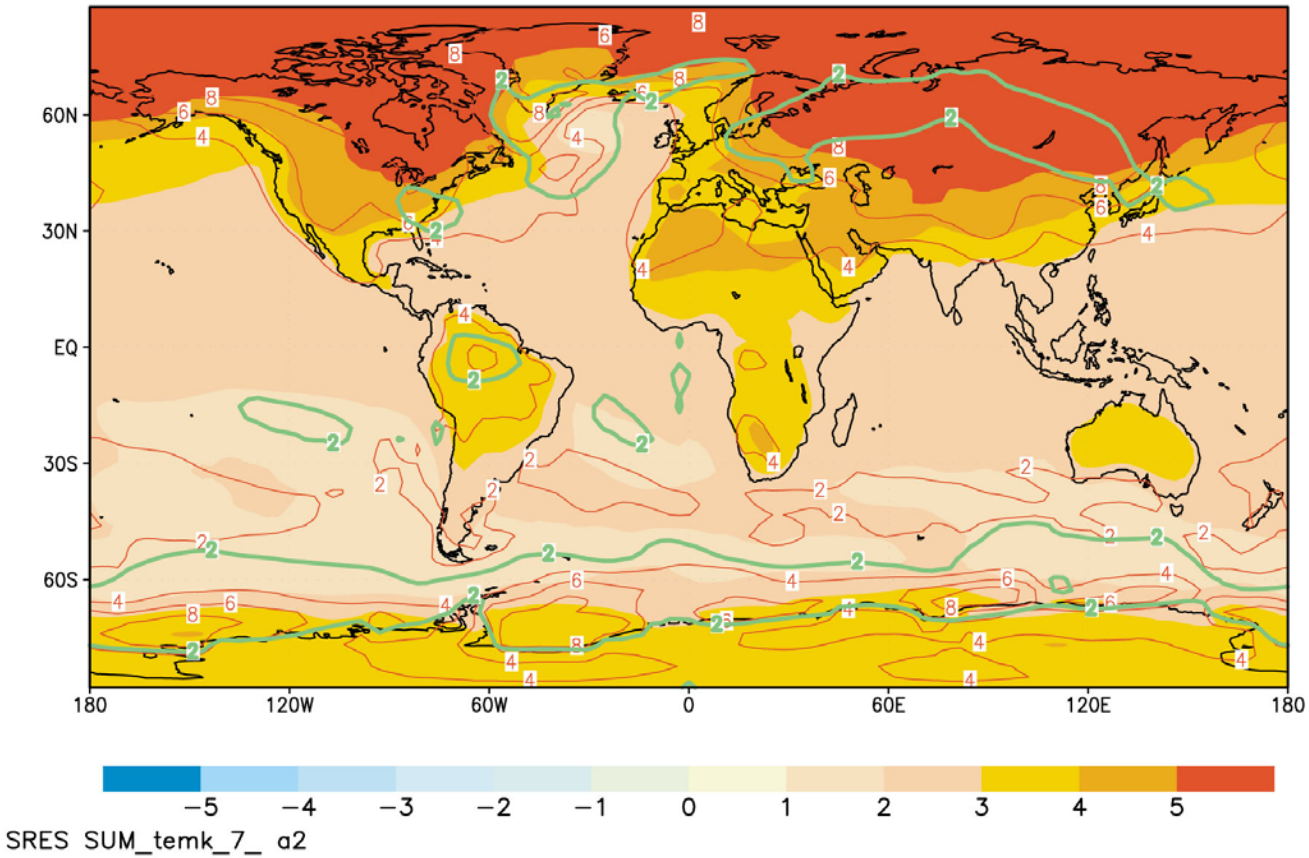
- Knowledge enhancement
  - Climatology
  - Hydrologic knowledge
  - Hydraulic knowledge
  - Flood damage analyses
  - Risk assessment

Knowledge enhancement

- Climatology
  - Understanding driving processes
  - Predicting future climate
    - GCM and RCM

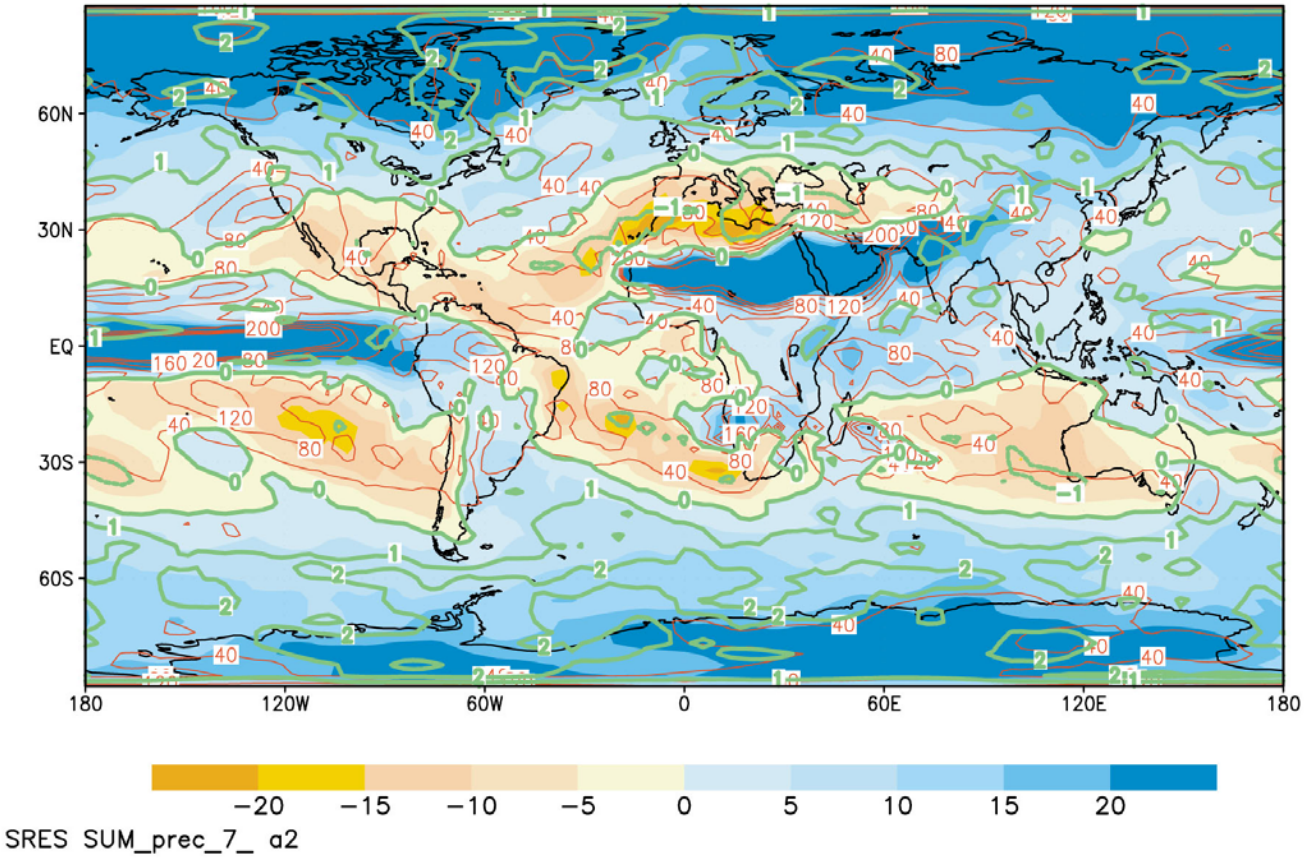
Knowledge enhancement

Temperature



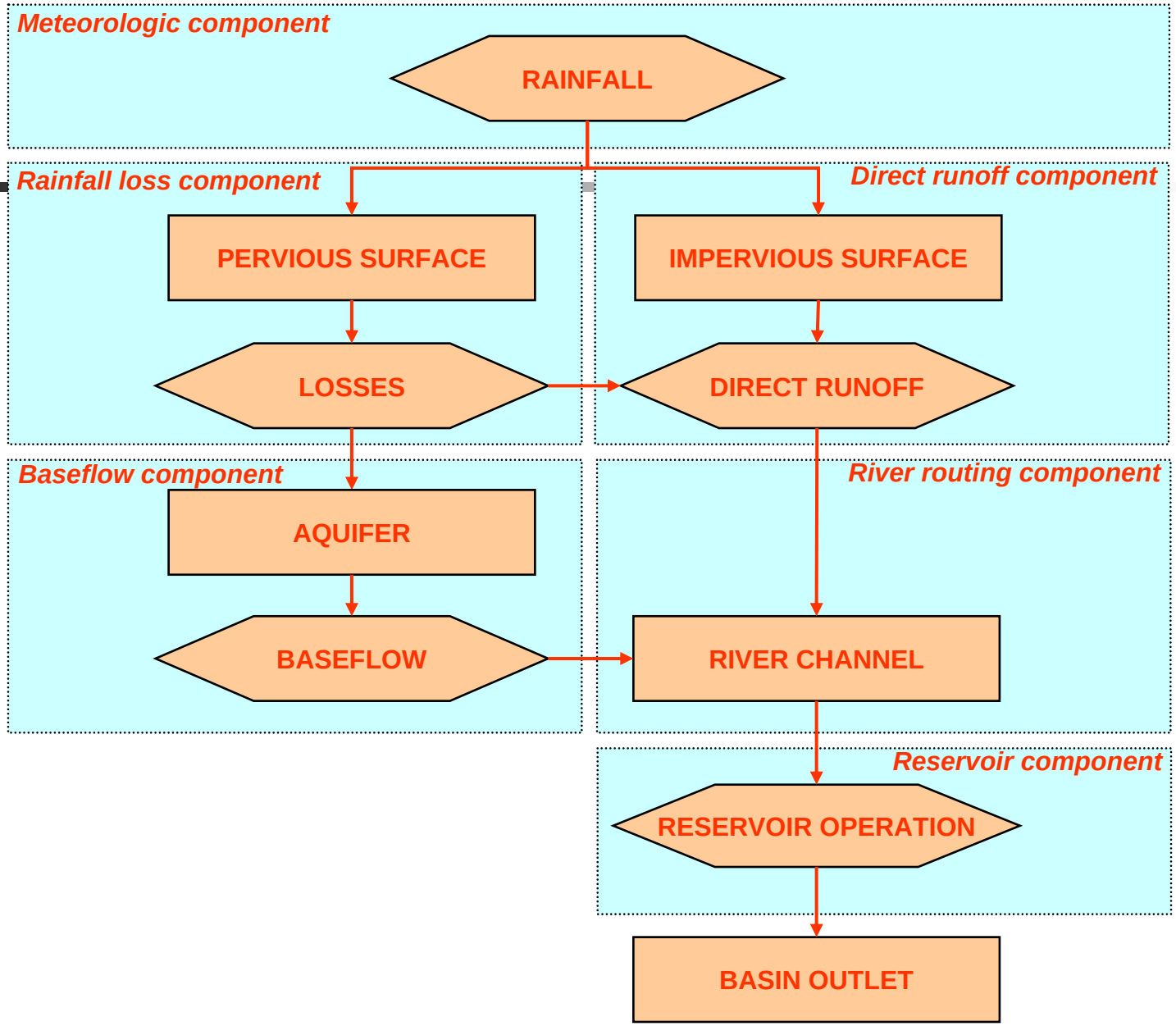
Knowledge enhancement

Precipitation



Knowledge enhancement

- Hydrology
  - Watershed response
  - Rainfall-runoff modeling
  - Event models (floods)
  - Continuous models (droughts)


Meteorologic component
RAINFALL
Rainfall loss component
Direct runoff component
PERVIOUS SURFACE
IMPERVIOUS SURFACE
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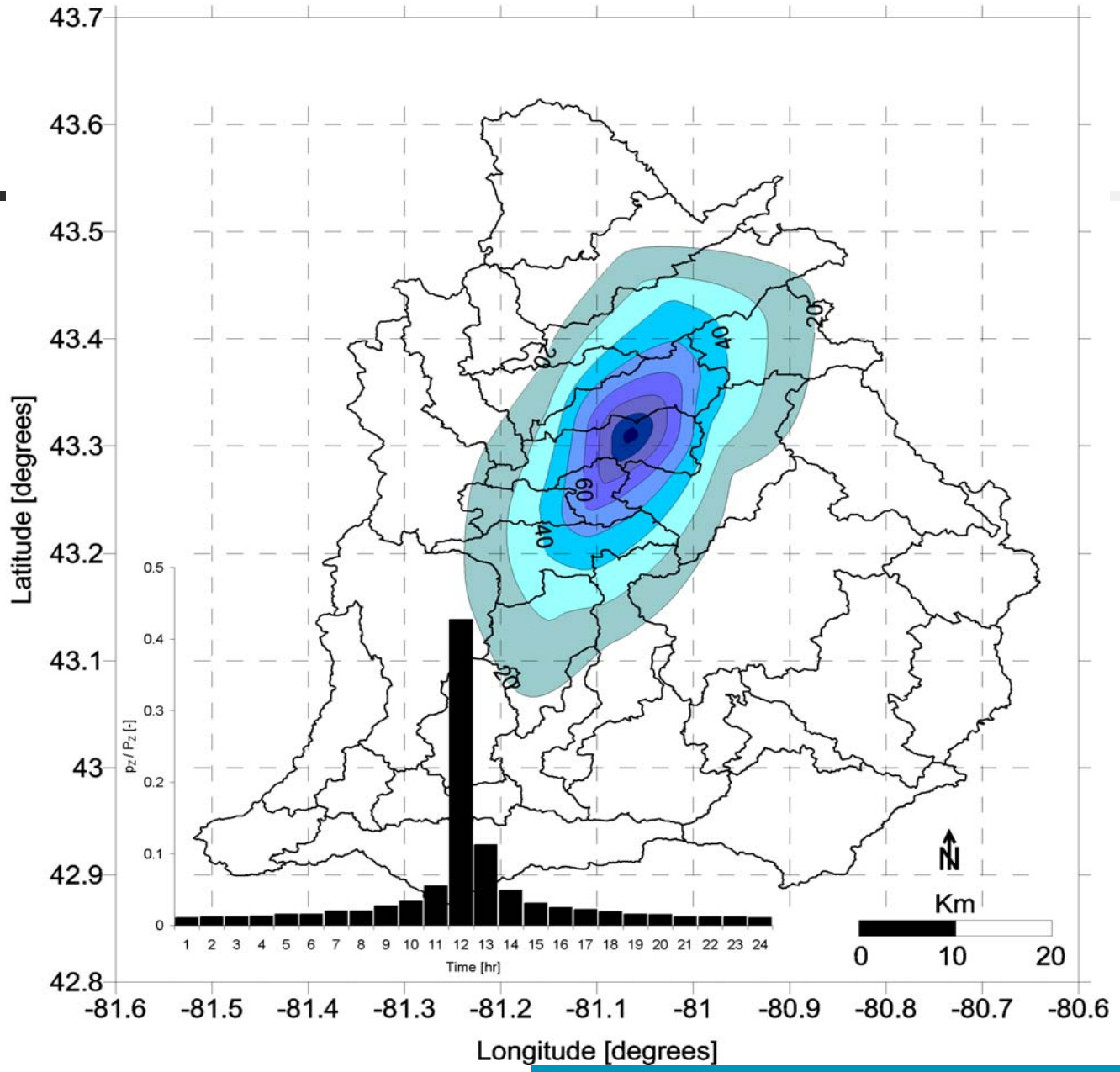
DIRECT RUNOFF
Baseflow component
River routing component
AQUIFER
BASEFLOW
RIVER CHANNEL
Reservoir component
RESERVOIR OPERATION
BASIN OUTLET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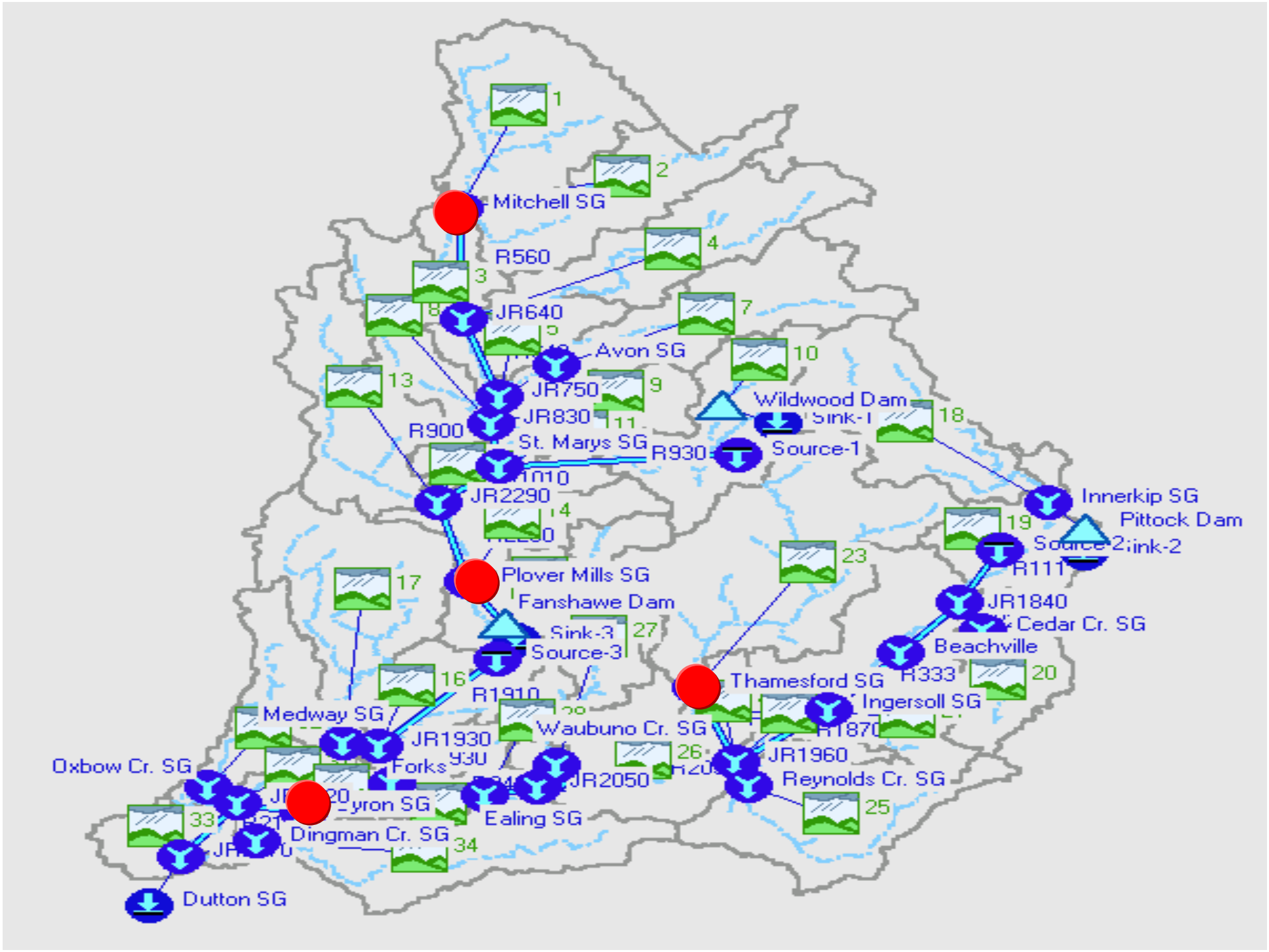
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Wildwood Dam
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St. Marys SG
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Source-1
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Innerkip SG
Pittock Dam
19
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R111
23
17
Plover Mills SG
Fanshawe Dam
JR1840
Cedar Cr. SG
Sink-3
27
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Beachville
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R1910
Thamesford SG
Ingersoll SG
Medway SG
Waubuno Cr. SG
JR1930
R1870
Oxbow Cr. SG
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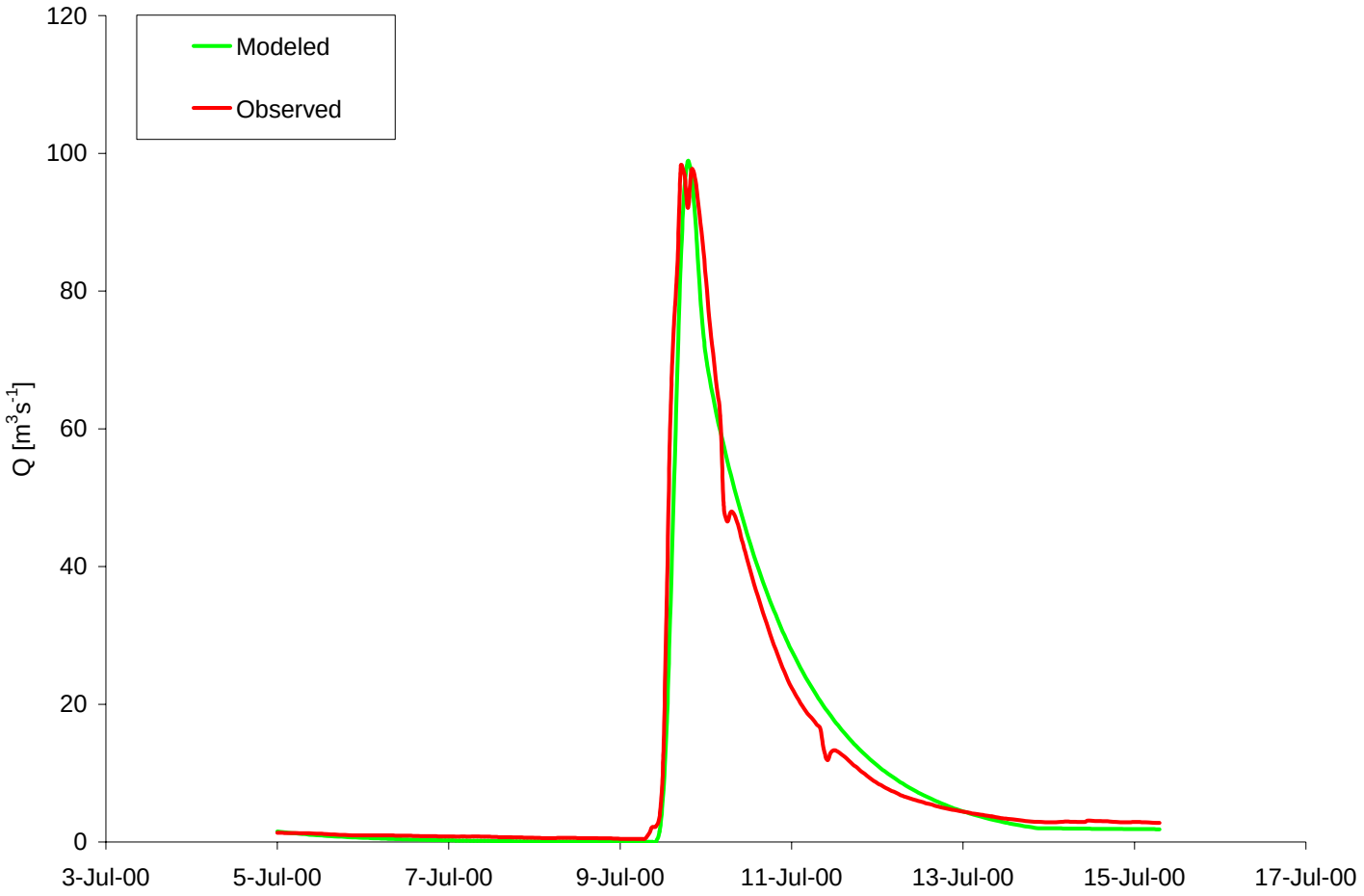
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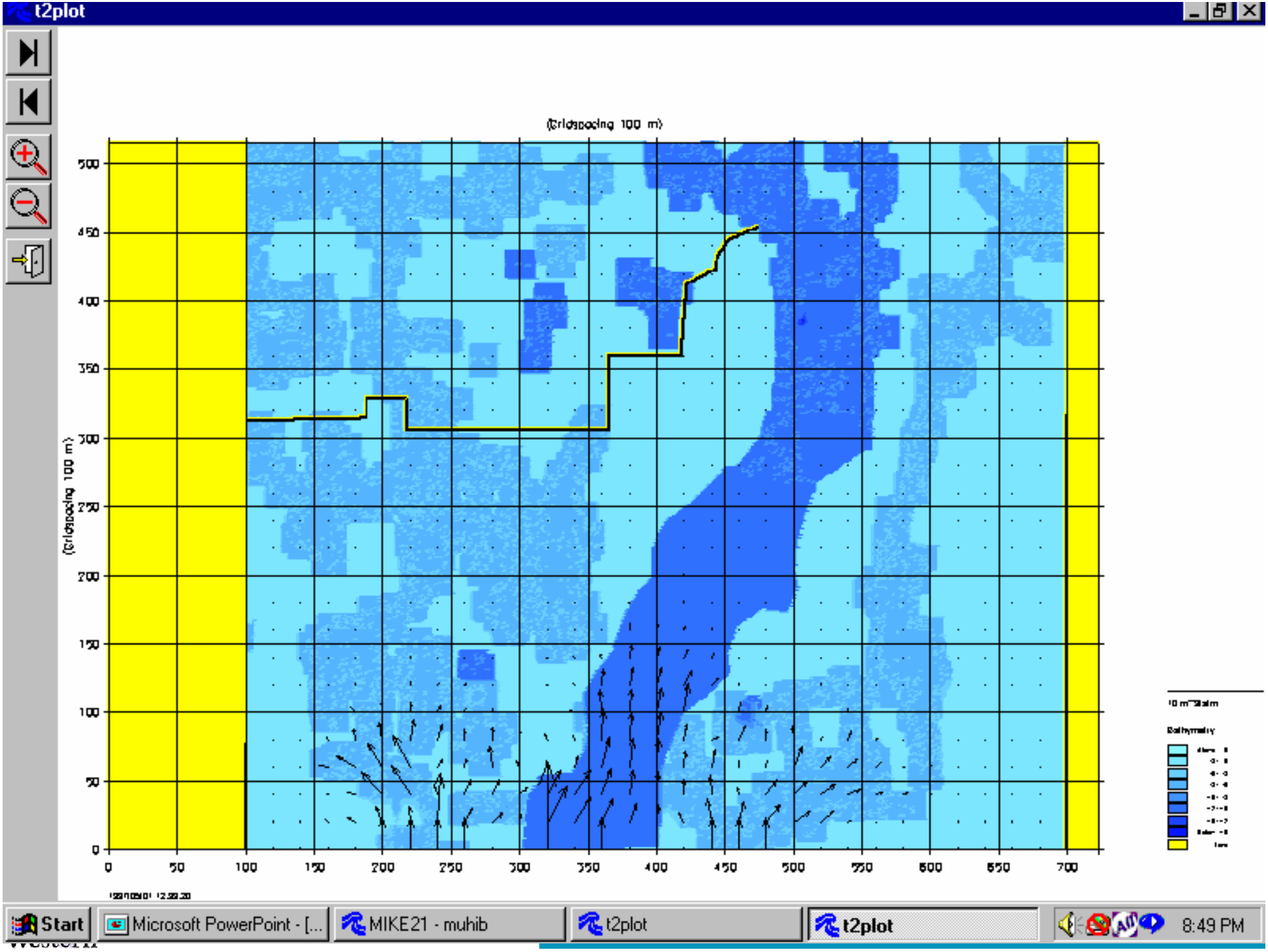
Knowledge enhancement

- Hydraulic modeling
  - Flow routing
  - Water depth calculation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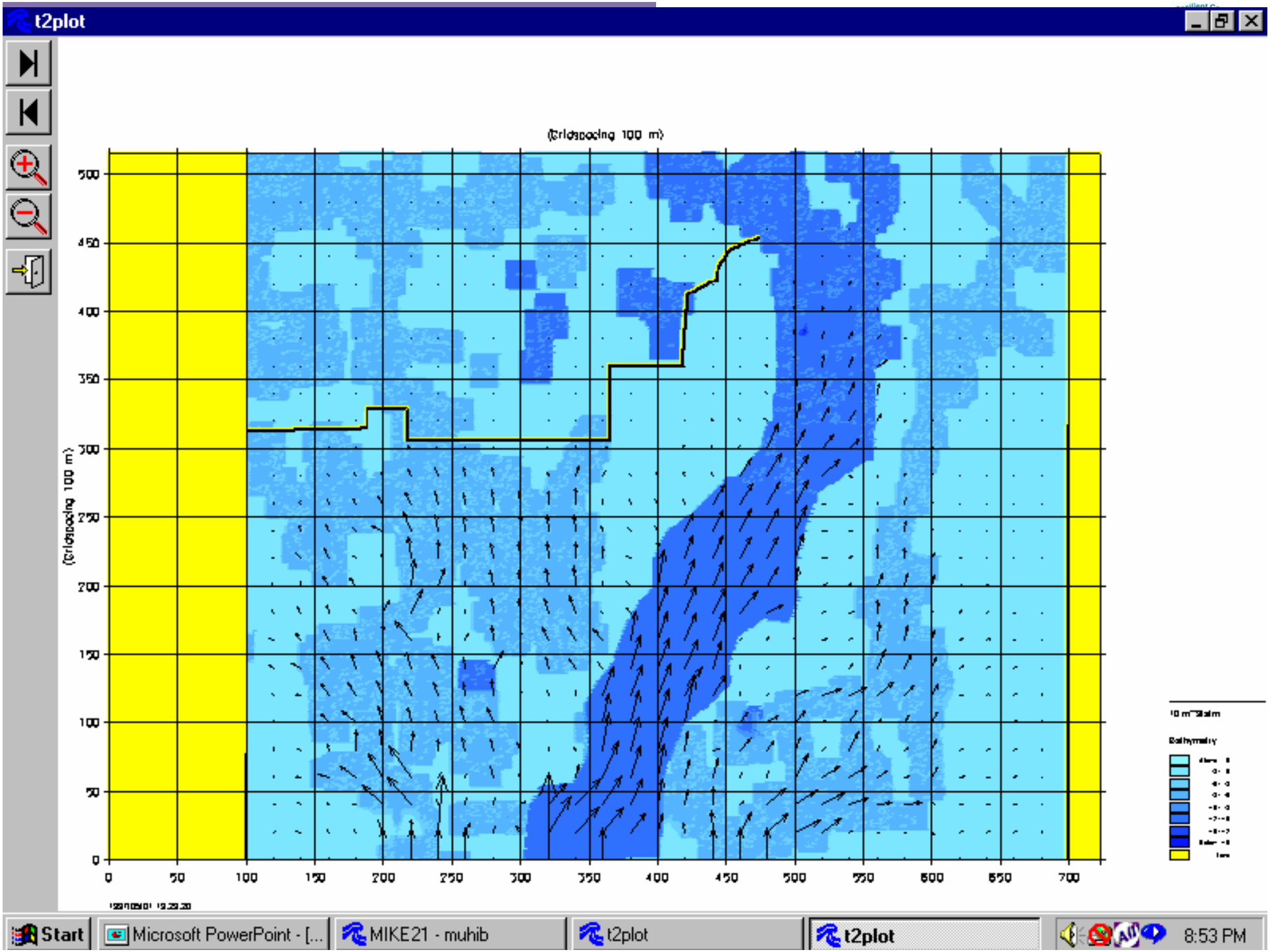
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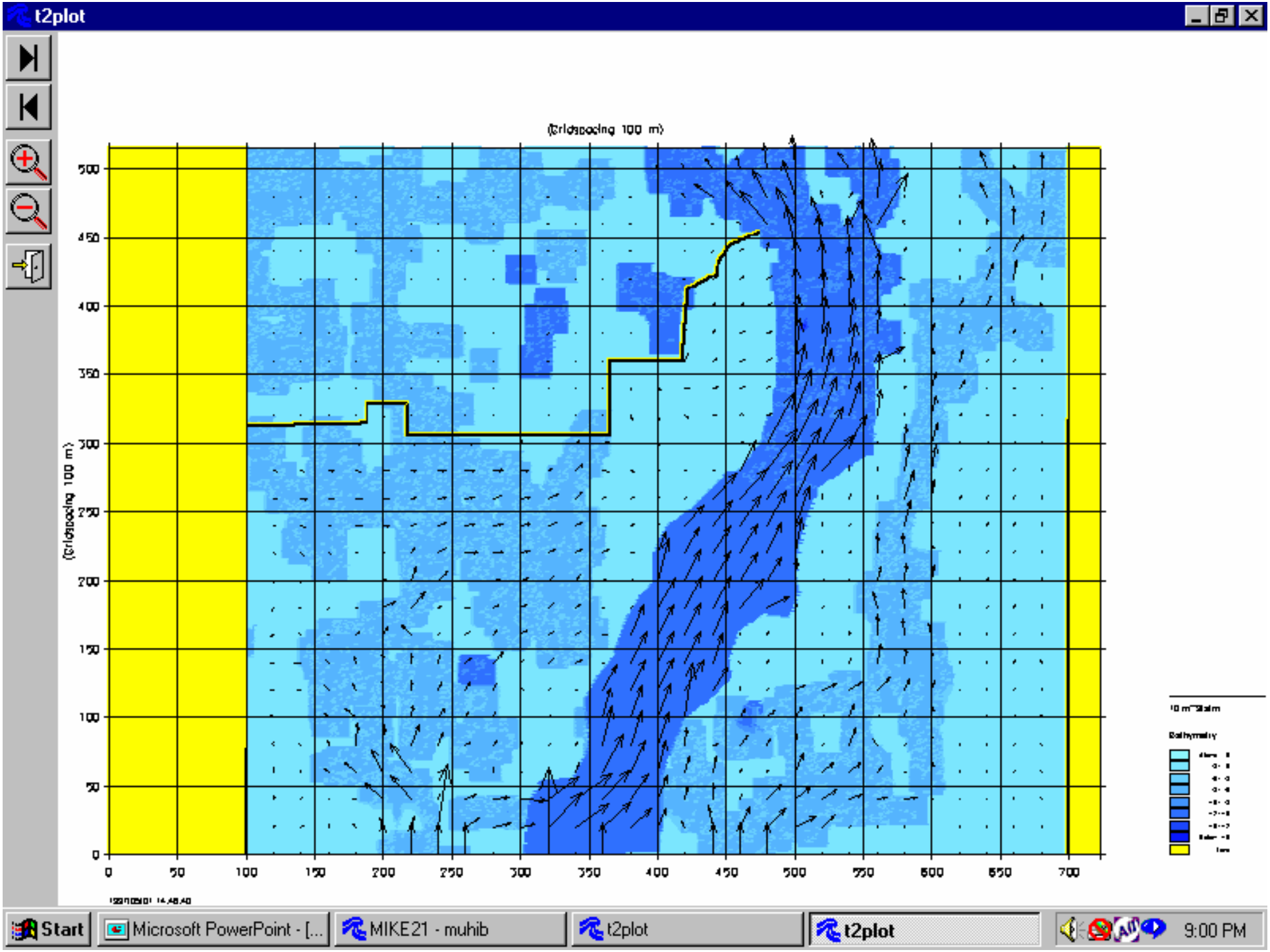
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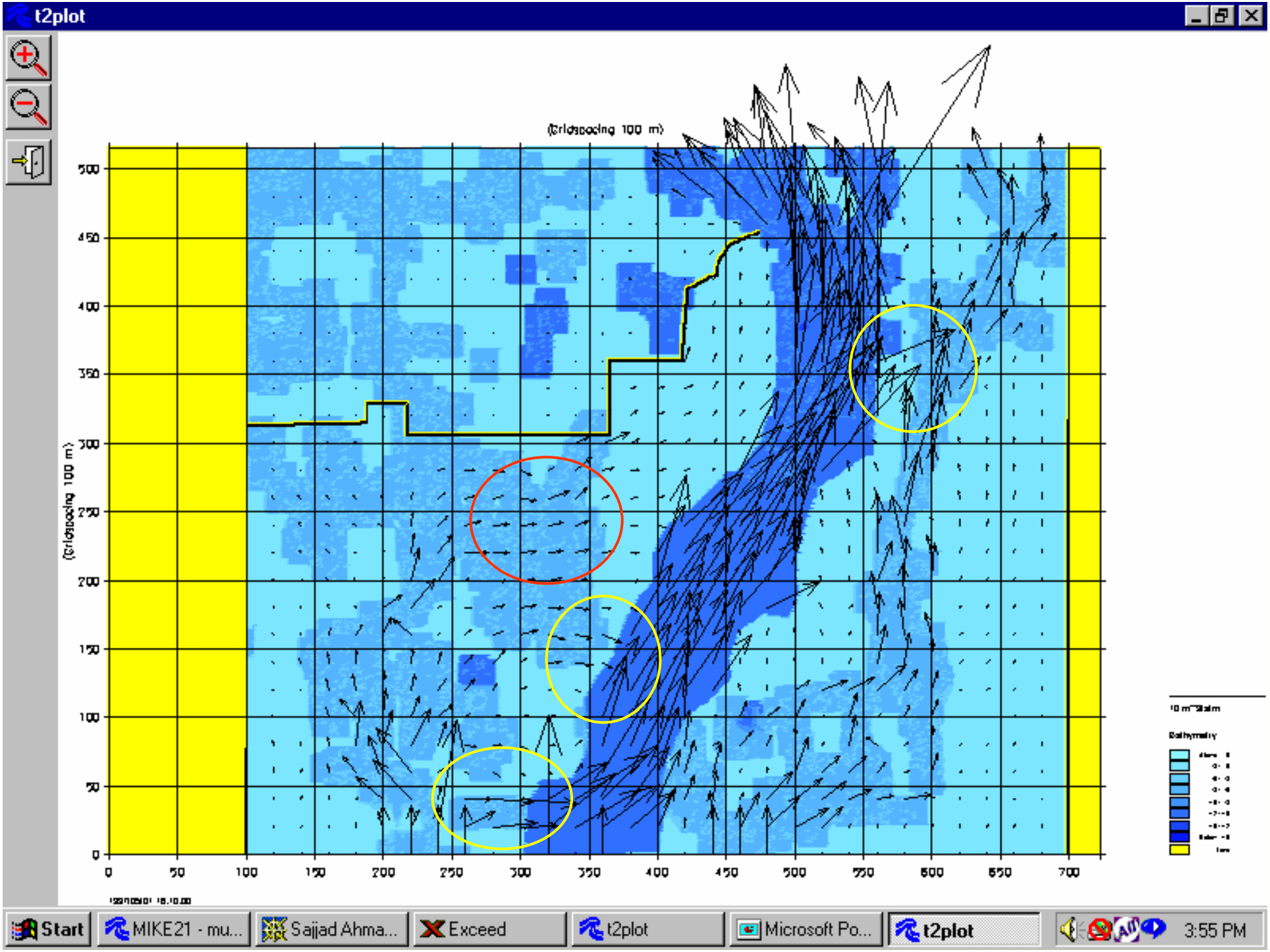
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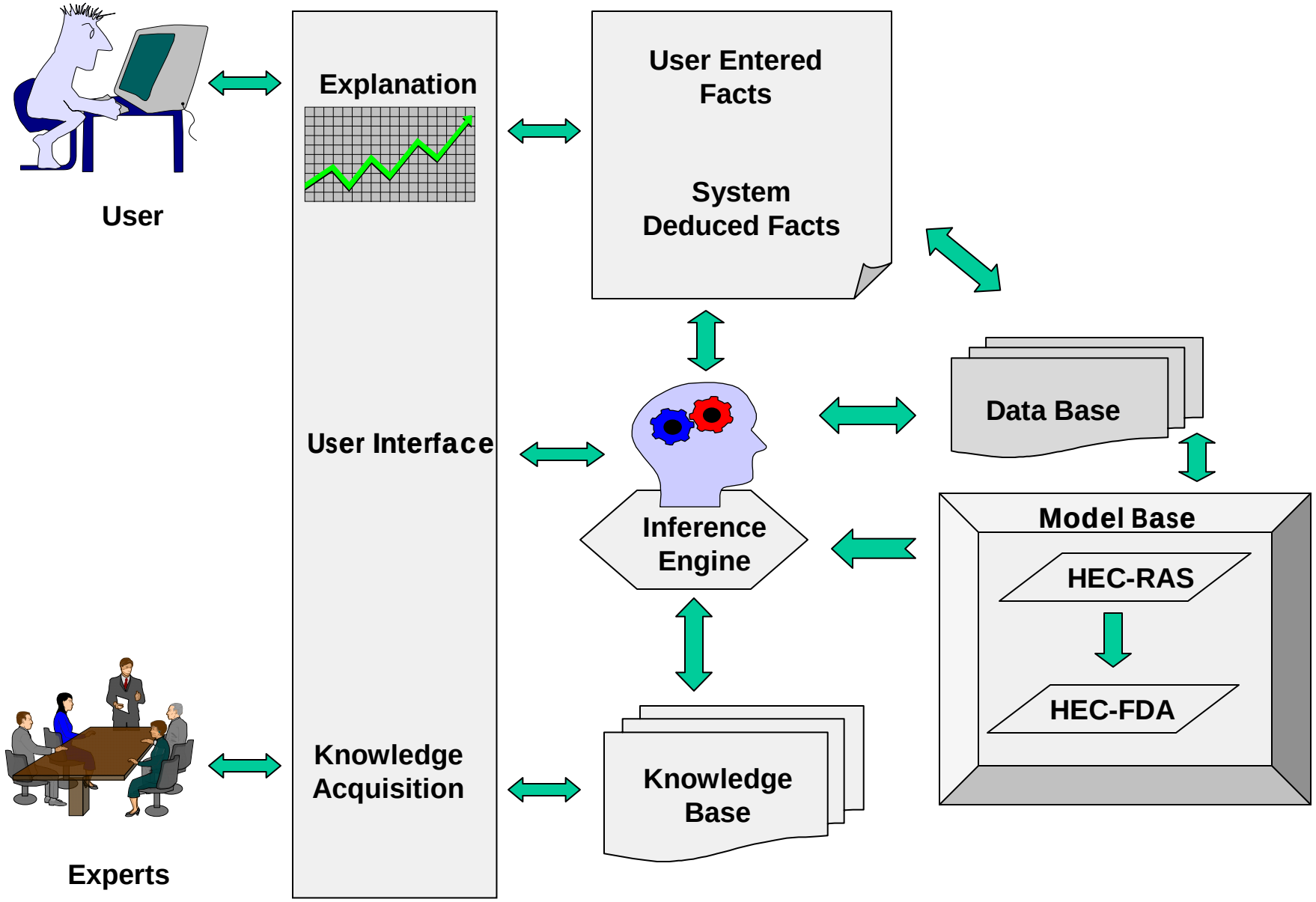
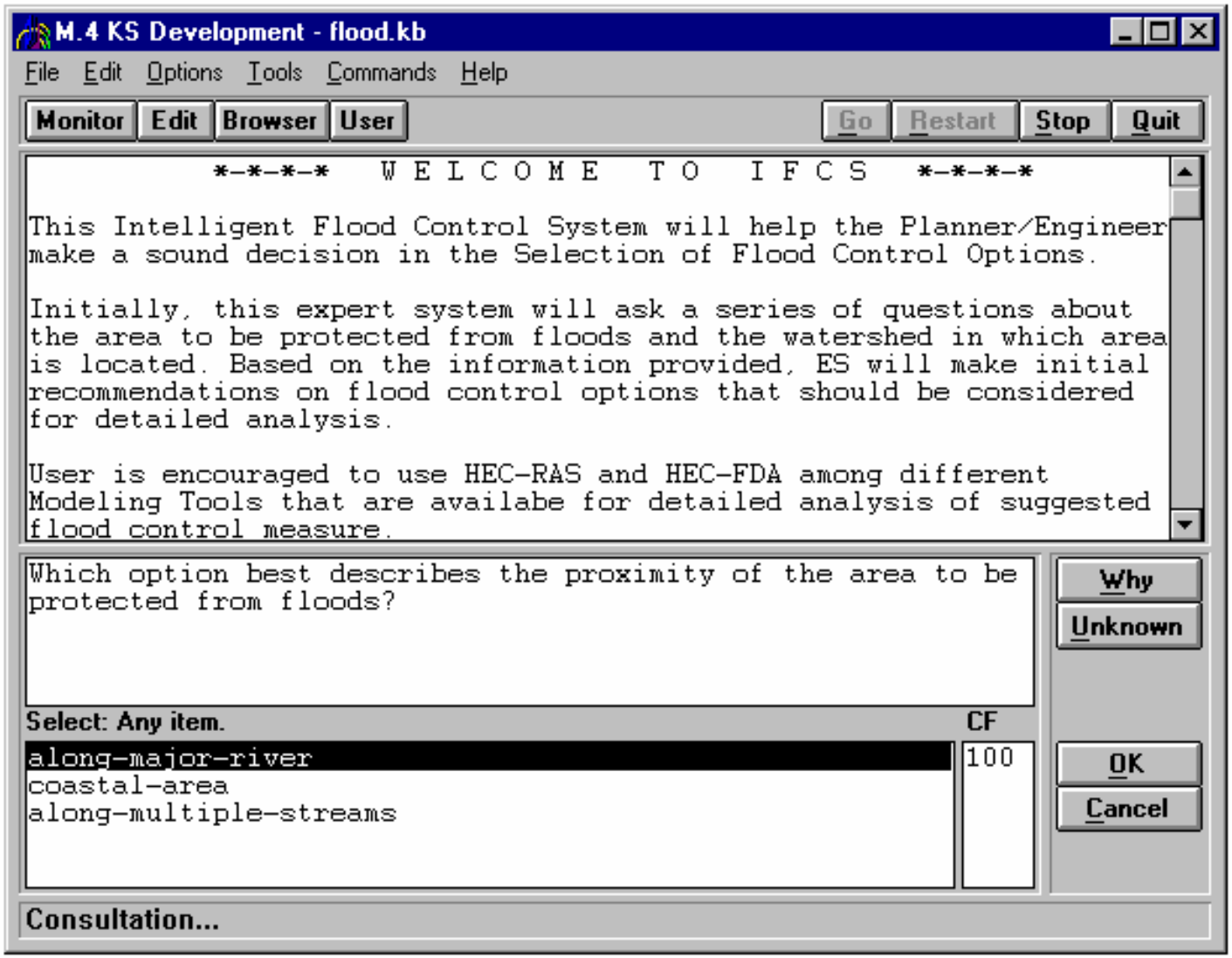
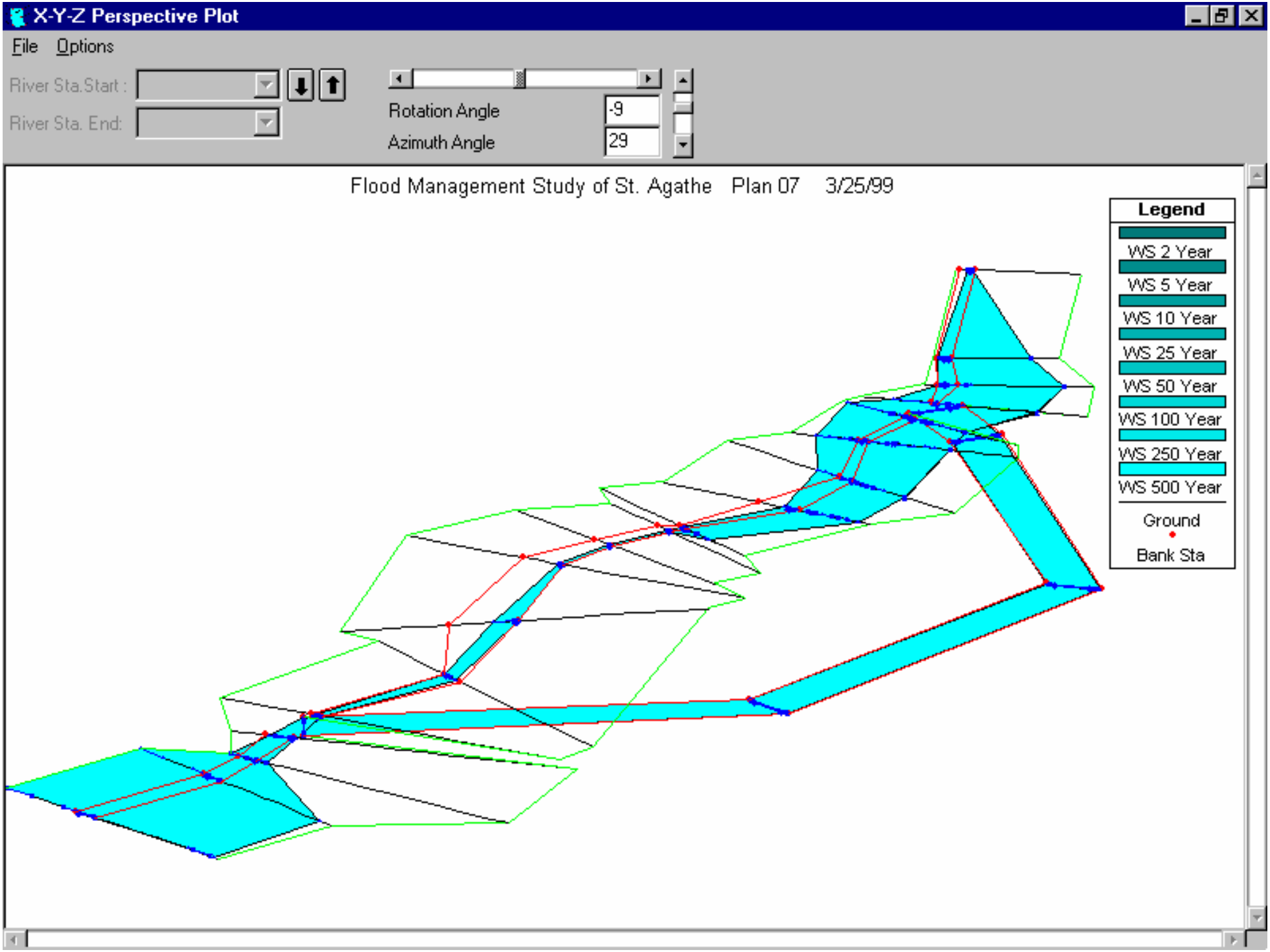
Knowledge enhancement

- Flood damage analyses
  - Development of flood protection measures
  - Floodplain regulations
  - Disaster assistance and compensation



Architecture of Intelligent Flood Control System IFCS


M.4 KS Development - flood.kb
File Edit Options Tools Commands Help
Monitor Edit Browser User
Go Restart Stop Quit
--*-* W E L C O M E T O I F C S *-*-*-*
This Intelligent Flood Control System will help the Planner/Engineer make a sound decision in the Selection of Flood Control Options.
Initially, this expert system will ask a series of questions about the area to be protected from floods and the watershed in which area is located. Based on the information provided, ES will make initial recommendations on flood control options that should be considered for detailed analysis.
User is encouraged to use HEC-RAS and HEC-FDA among different Modeling Tools that are availabe for detailed analysis of suggested flood control measure.
Which option best describes the proximity of the area to be protected from floods?
Why
Unknown
Select: Any item.
CF
along-major-river
coastal-area
along-multiple-streams
100
OK
Cancel
Consultation...


X-Y-Z Perspective Plot
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Flood Management Study of St. Agathe Plan 07 3/25/99
Legend
WS 2 Year
WS 5 Year
WS 10 Year
WS 25 Year
WS 50 Year
WS 100 Year
WS 250 Year
WS 500 Year
Ground
Bank Sta

Flood Management Options - Structure Inventory

File Edit View Utilities Help

Individual Structure: 1

Stream Station: 10.000

Structure Value ($'s): 100.00

Content Value ($'s):

Other Value ($'s):

Update

Cancel

Structure Stages...

Optional Information...

Bank: Left Right

Damage Category: Total

Occupancy Type: Buildings

Stream: Red River

Module: Base

Define Direct Structure Information

First Floor Stage Error (stdev in m.):

Depth-Direct Dollar Damage Function

Structure... Content...

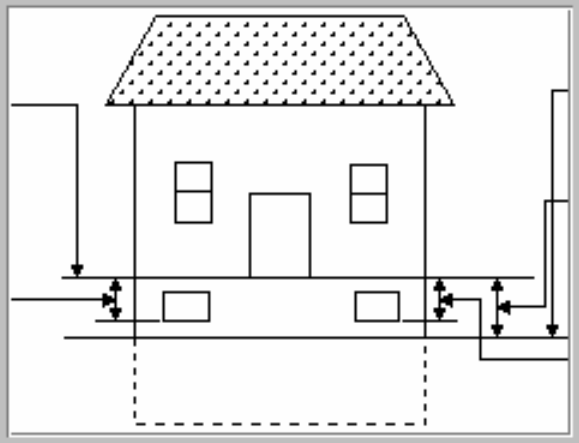
1 of 10

Flood Management Options - Structure Stages

First Floor Ground Stage

First Floor Stage: 232.00

Beginning Damage Depth: 228.0

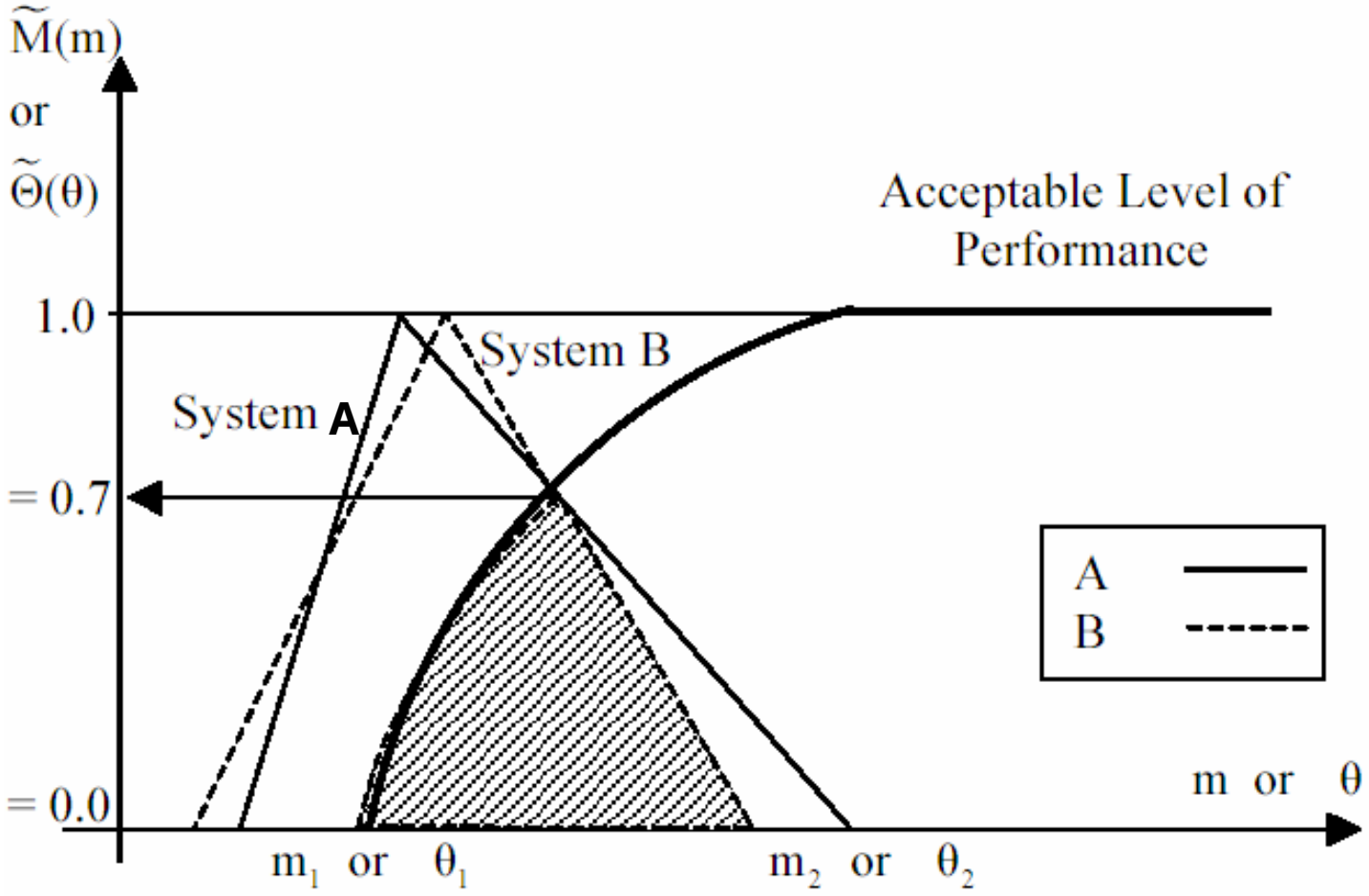


OK Cancel Help

Knowledge enhancement

- Risk assessment
  - Probabilistic
  - Fuzzy sets
  - Objective and subjective uncertainty
  - Risk communication

Risk management



March – April, 2004 ; Manitoba flooding

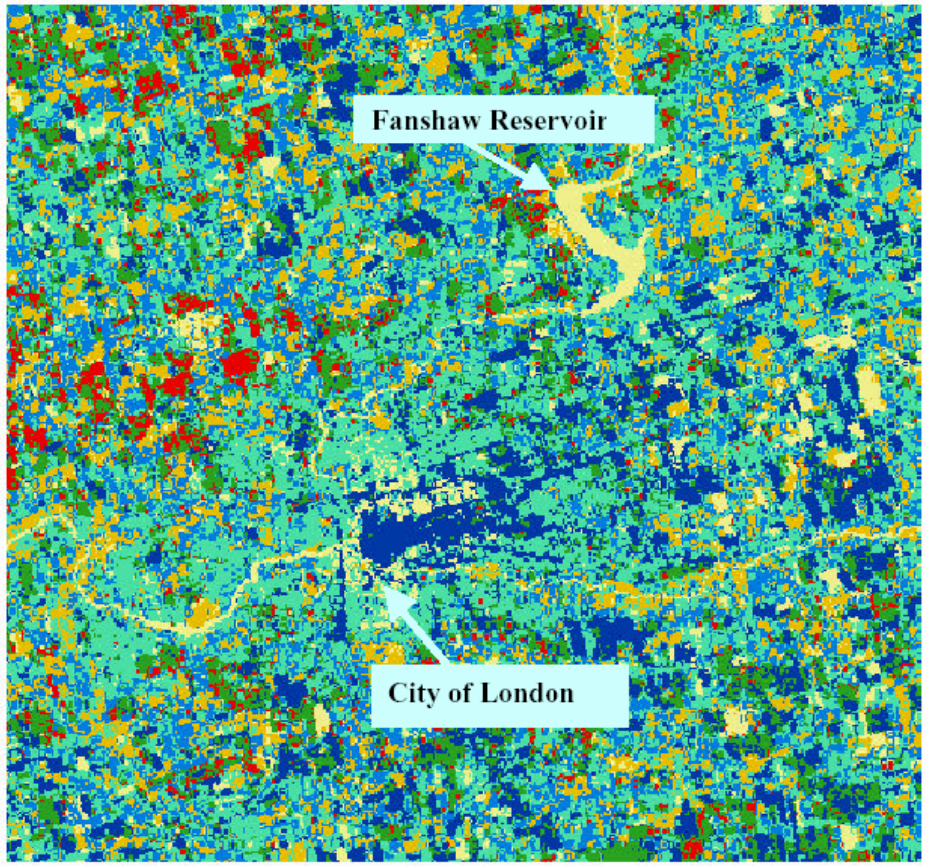
March – April, 2004 ; Manitoba flooding

March – April, 2004 ; Manitoba flooding

Opportunities

- Use of technology
  - Remotely sensed data
  - Detailed DEMs (lidar for example)
  - Virtual databases
  - Integrated decision support

1974


Fanshaw Reservoir
City of London
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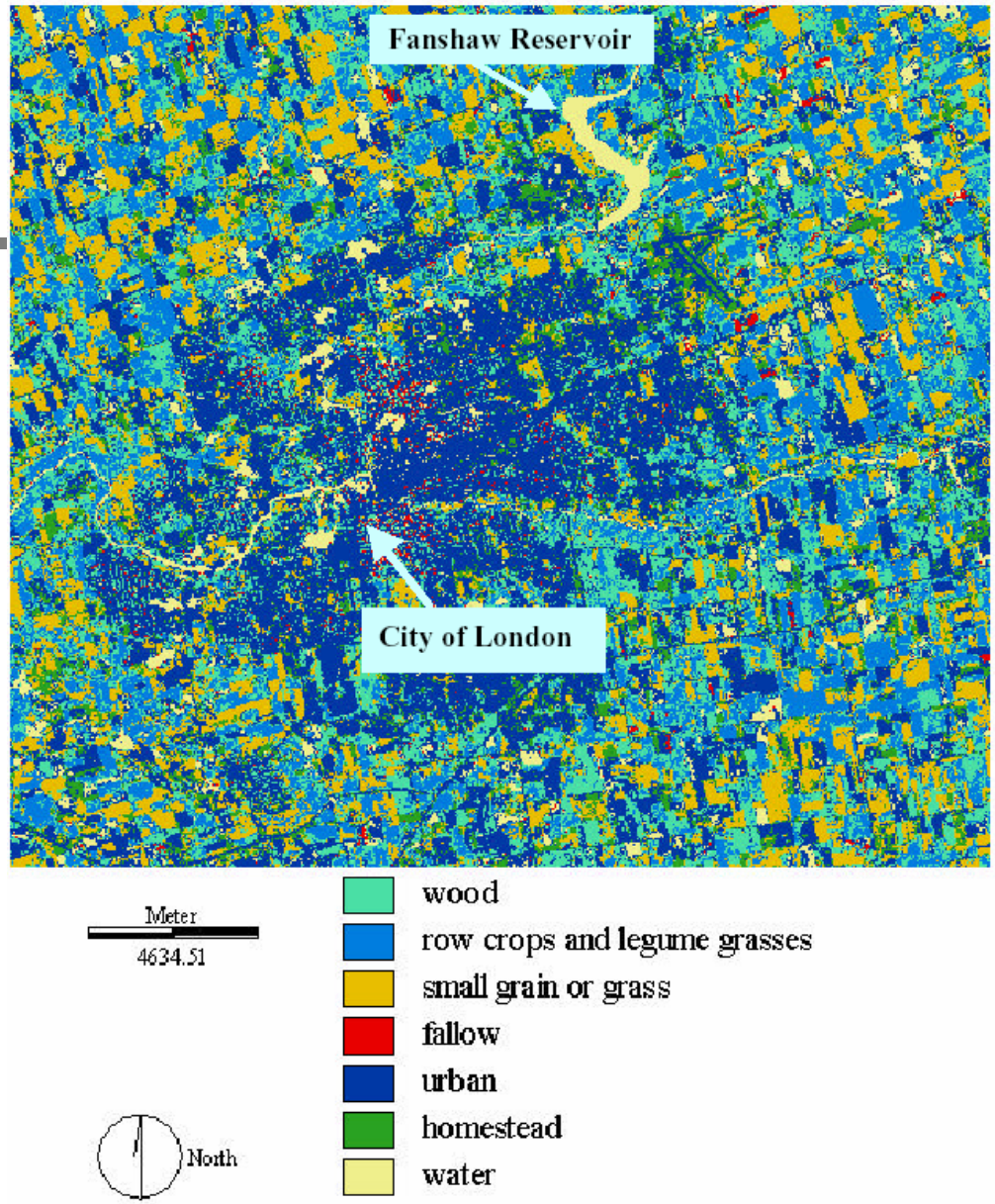
small grain or grasses
fallow
urban
homestead
water

1983


Fanshaw Reservoir
City of London
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urban
homestead
water

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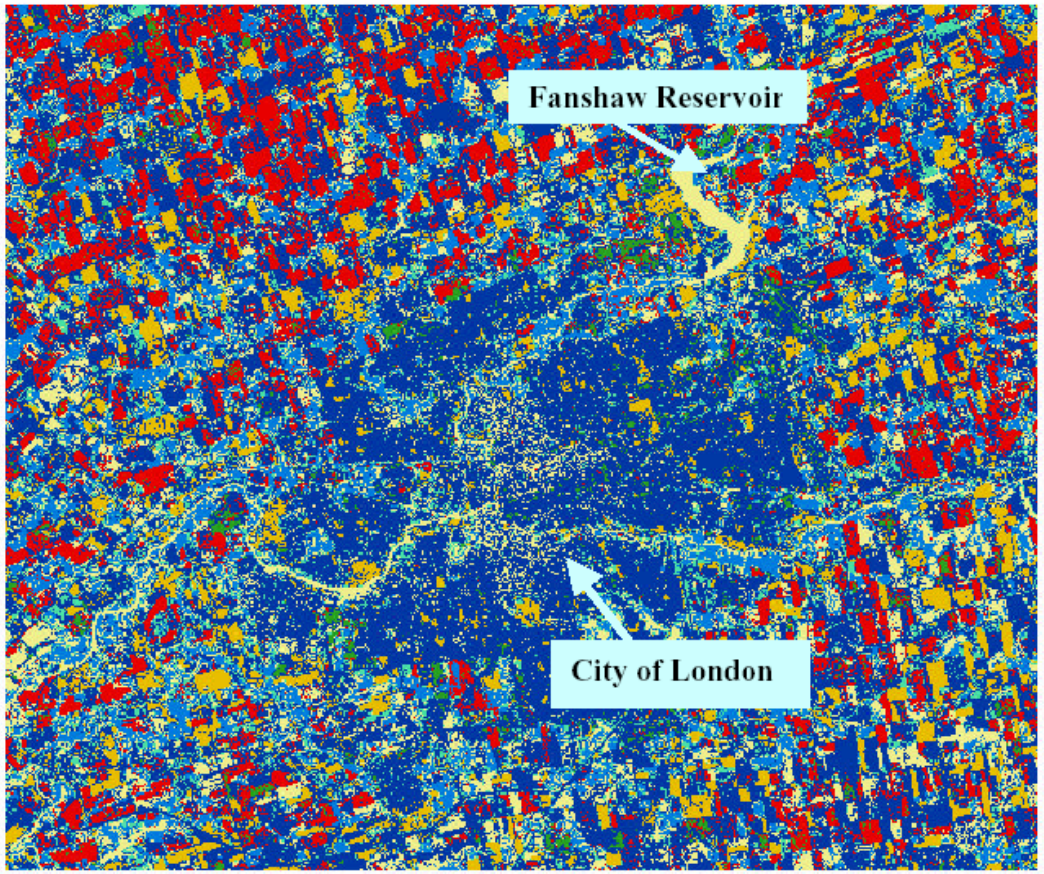
Fanshaw Reservoir
City of London
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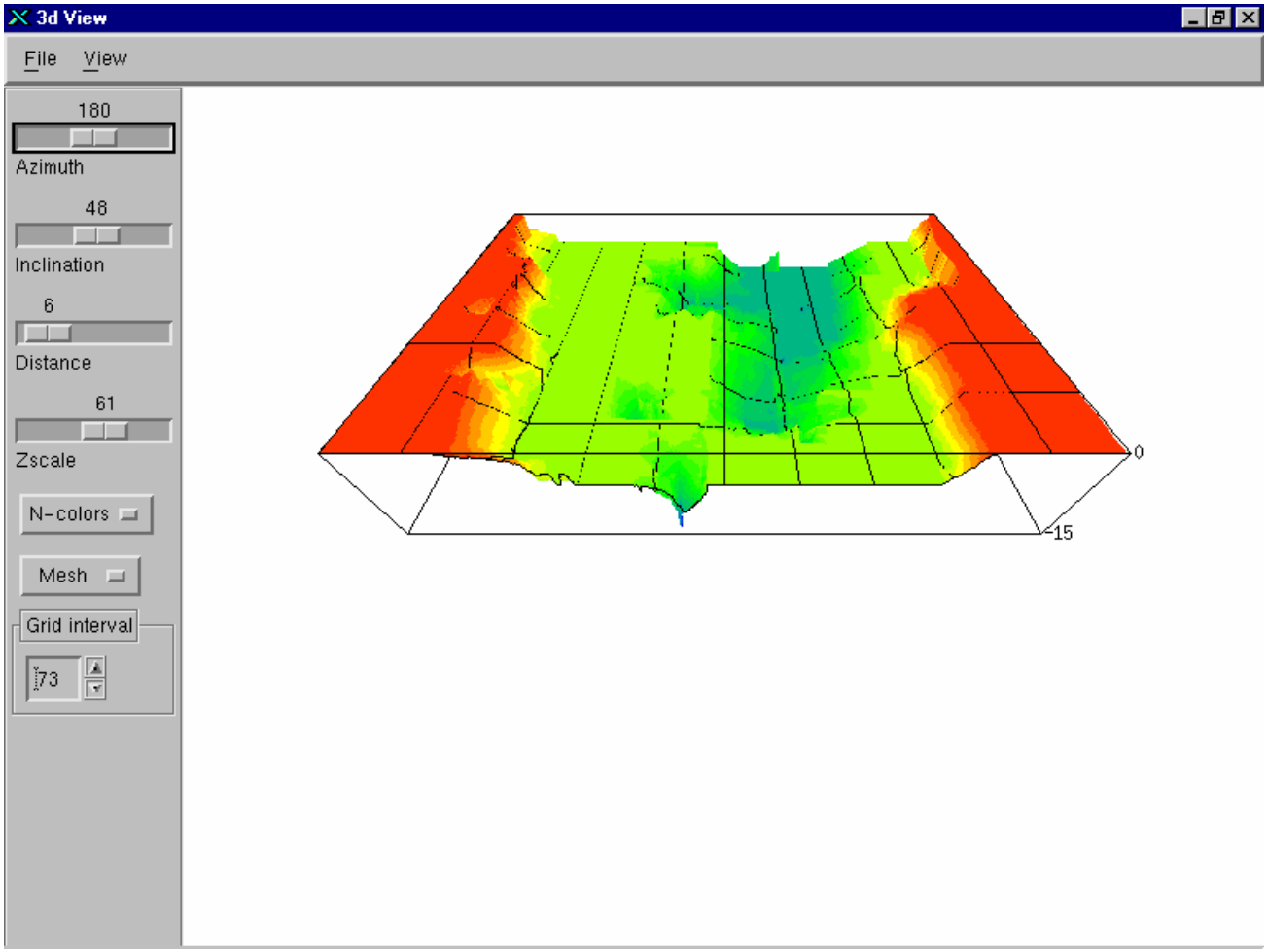
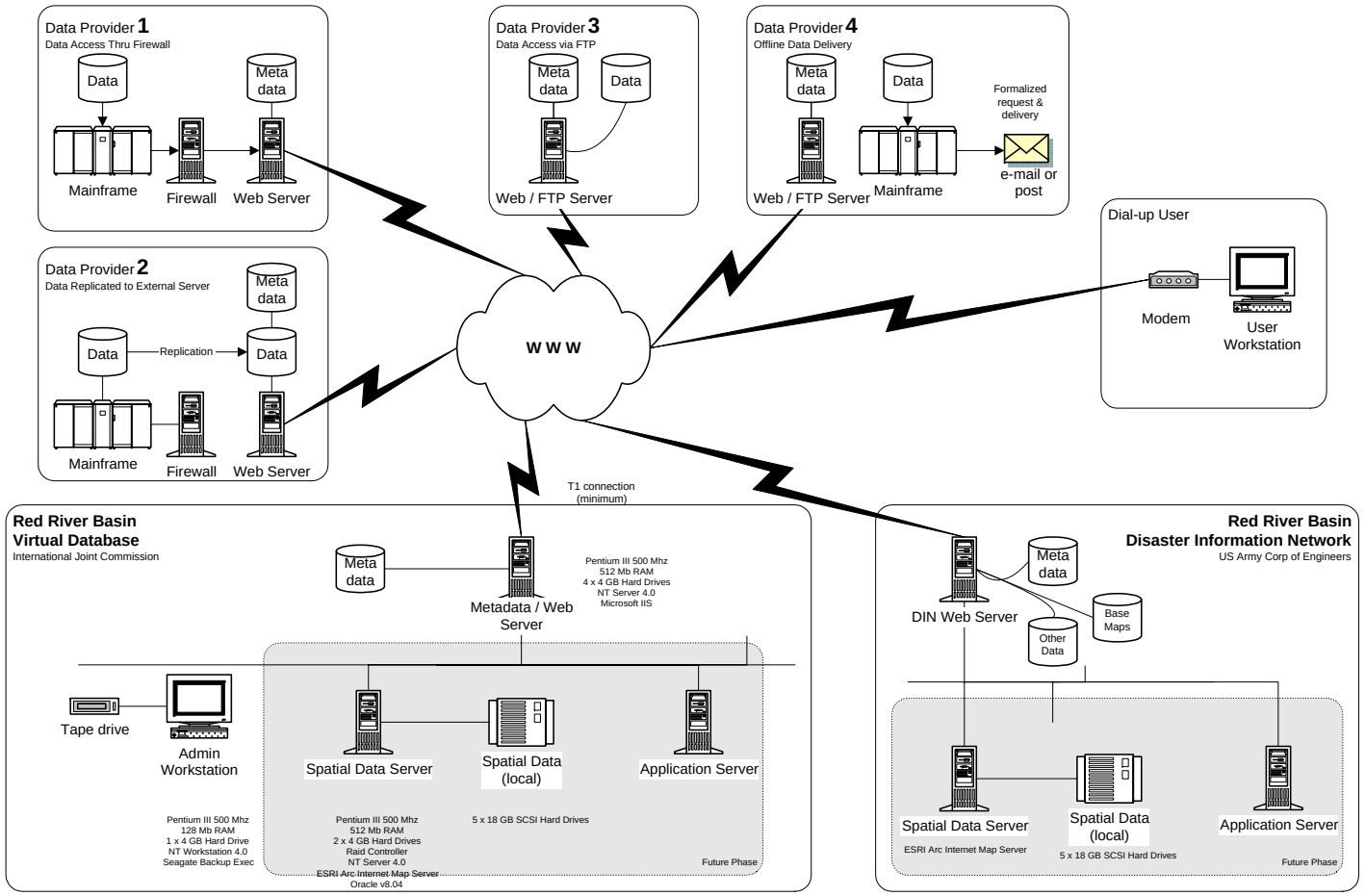
LIDAR floodplain maping

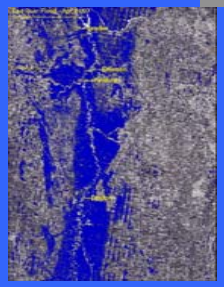


Virtual database



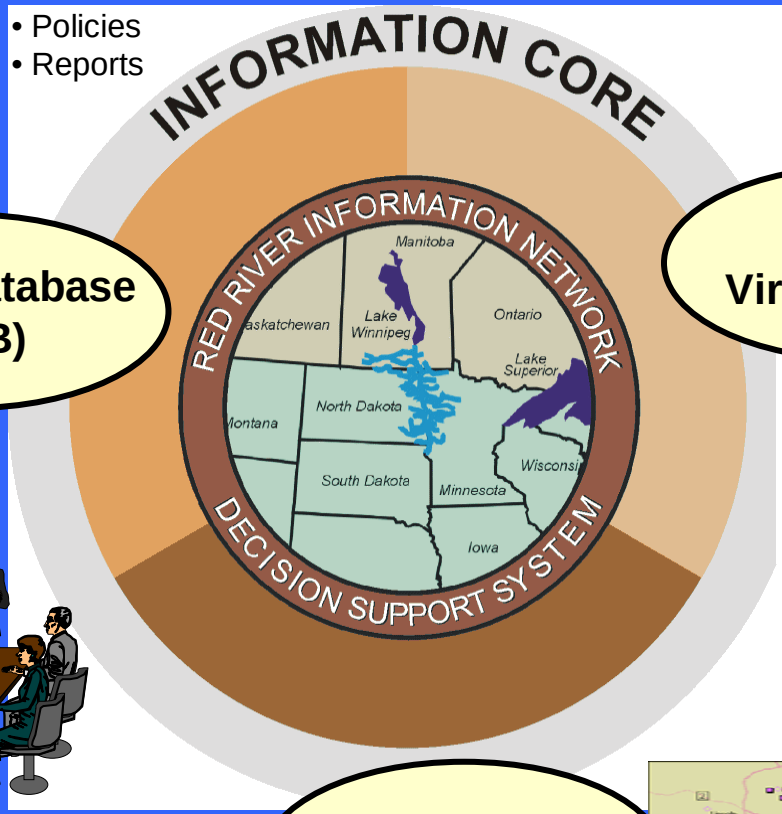
Red River Basin Virtual Database Technical Model

Data
Metadata



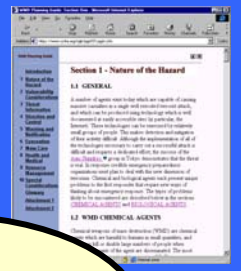
- Imagery
- Environmental
- Hydro-Met.
- Socioeconomic
- Template Data

- Plans
- Policies
- Reports



Virtual Database (VDB)

EIIP Virtual Forum



- USACE EngLink

WWW Search Tools
Geospatial Viewer

- **Surveys of User Needs**
- **Inventories of Resources & Capabilities**
- **Assessments of AARs**
- **Lessons Learned**

Stakeholders Input

Modeling & Simulation

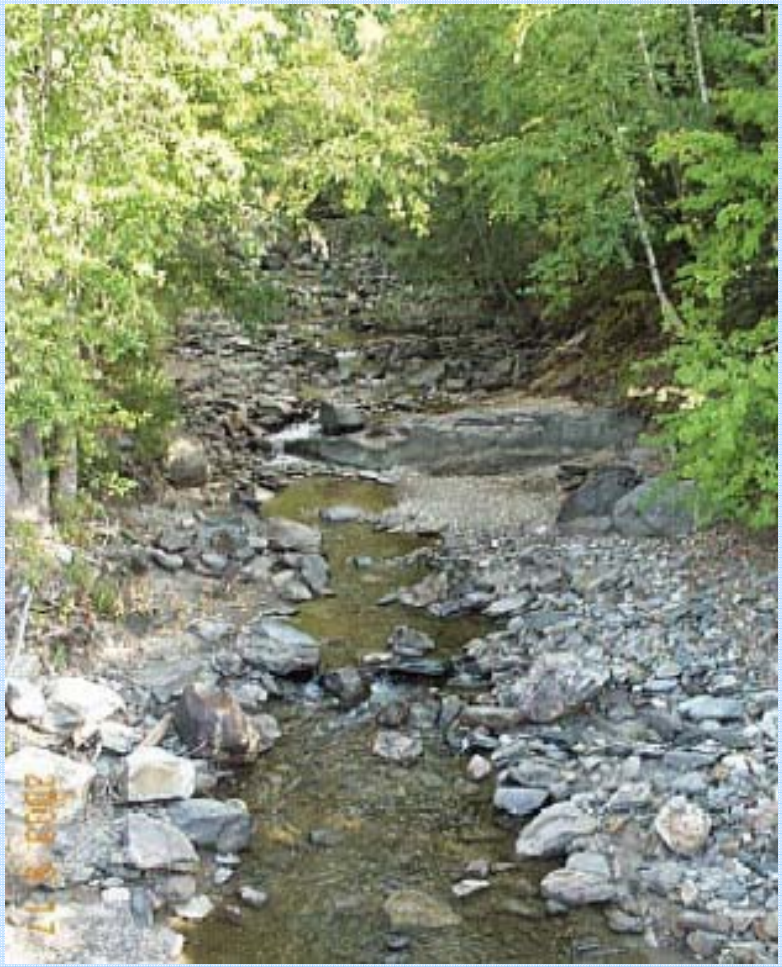
Databases, models, Interfaces,
Delivery System, Comm's Links

July, 2004 ; Edmonton flooding

Opportunities

- Capacity building
  - Local knowledge
  - Participation of stakeholders
  - Mitigation strategies

July , 2004 ; Drought in British Columbia



July , 2004 ; Drought in British Columbia

July , 2004 ; Drought in British Columbia

Workshop

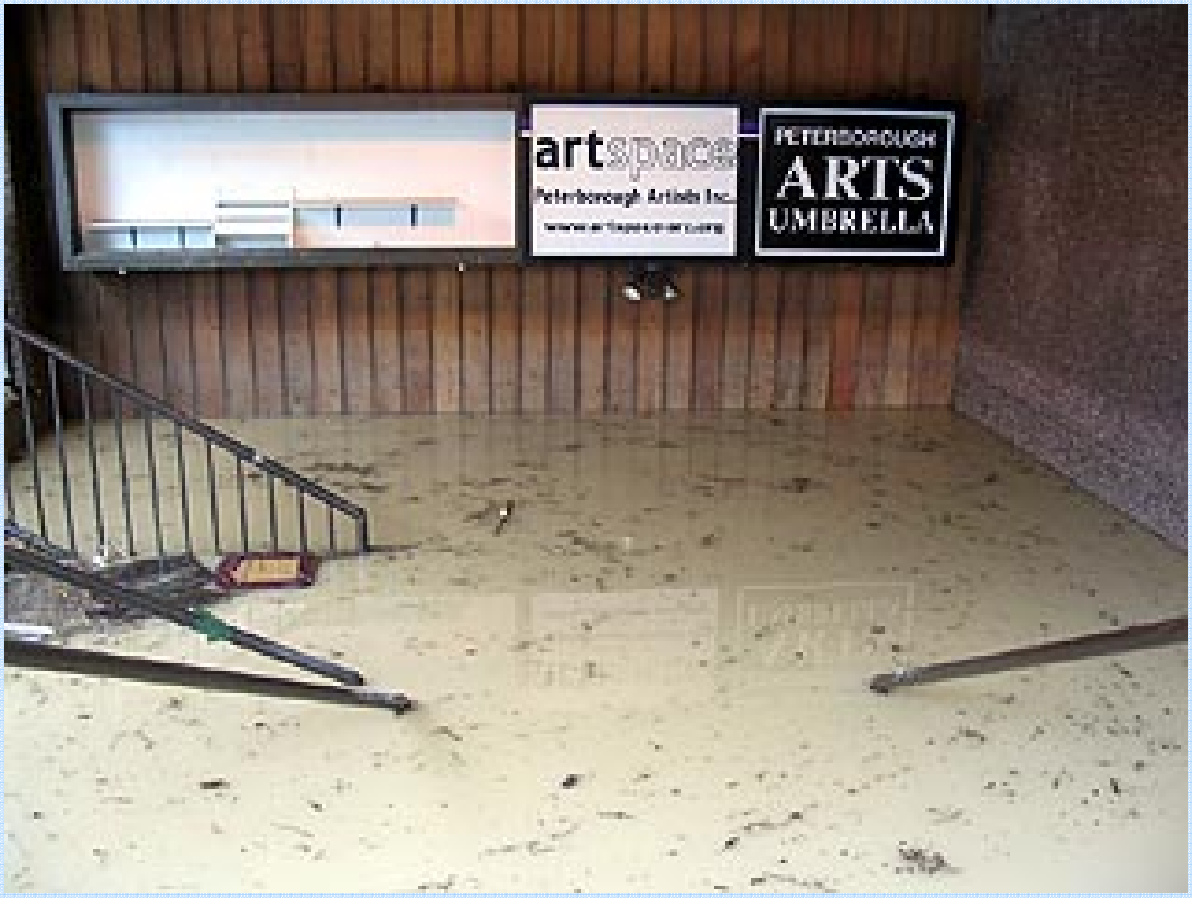
- On the way to Kobe, Japan.
  - Review of international and national initiatives
  - Sharing experience
  - Sharing knowledge
  - Research and practice
  - Interdisciplinarity in action

July, 2004 ; Peterborough flooding

July, 2004 ; Peterborough flooding

July, 2004 ; Peterborough flooding

July, 2004 ; Peterborough flooding

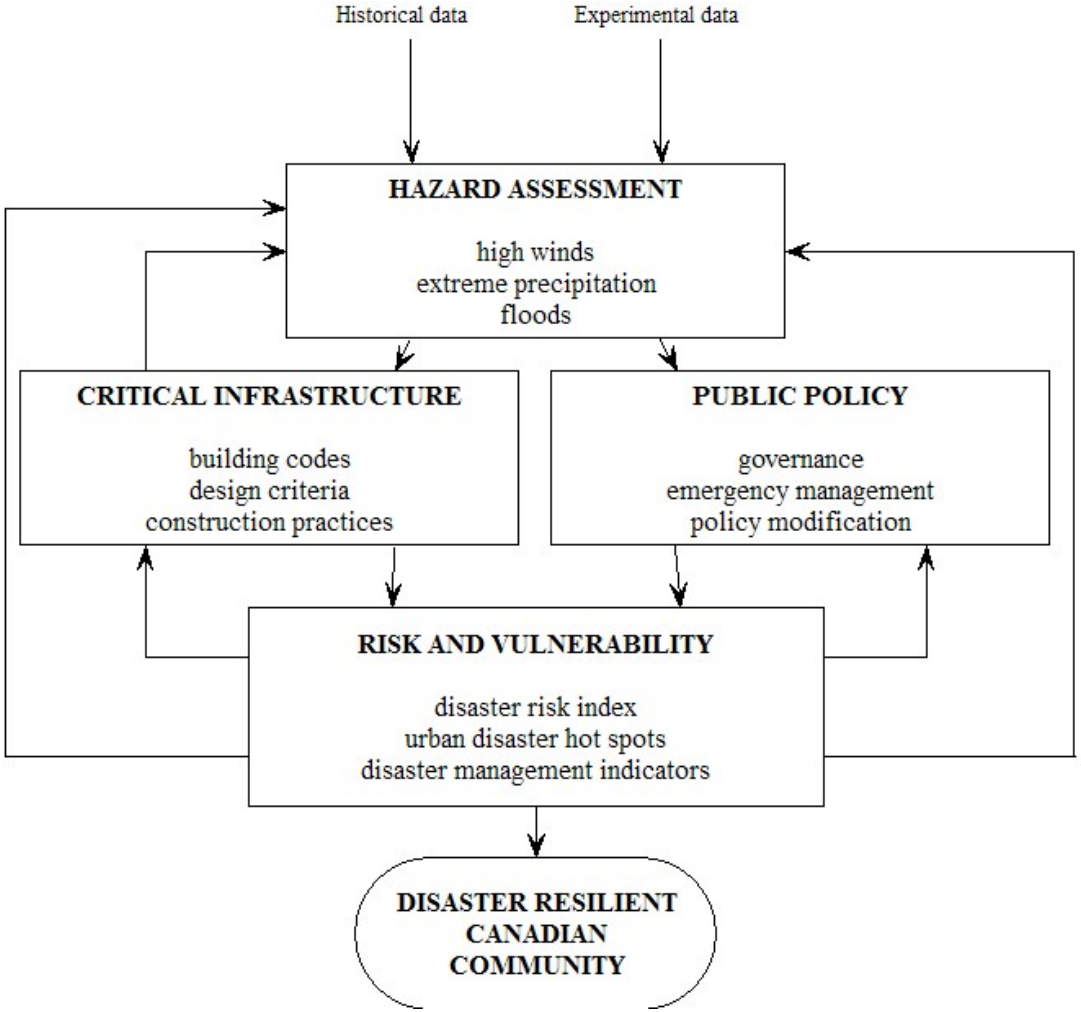


July, 2004 ; Peterborough flooding

ICLR research network

- Research Alliance for Disaster Resilient Cities – RADR-Cities
  - Academic institutions
  - Government agencies
  - Private sector
  - Non-governmental organizations

ICLR research network



August, 2004 ; New Brunswick flooding

September, 2004 ; Quebec City flooding

Instead of conclusion