THE JAPAN FEDERATION OF ENGINEERING SOCIETIES

THE ARCHITECTURAL INSTITUTE OF JAPAN

THE JAPAN SOCIETY OF CIVIL ENGINEERS

THE WORLD FEDERATION OF ENGINEERING ORGANZATIONS

The 11th Joint International Symposium on Disaster Risk Management

Flood disaster in July 2017, northern Kyushu

Earthquake disaster in April 2016, Kumamoto

THE SCIENCE COUNCIL OF JAPAN

September 13, 2017
Ito Campus, Kyushu University, Fukuoka, JAPAN

The 11th Joint International Symposium on Disaster Risk Management

Large, severe natural disasters caused by earthquakes and extreme weather-induced floods and landslides have often occurred in Japan. For example, Kumamoto area (the southeastern Japan) experienced two catastrophic earthquakes with the highest intensity (Japanese seismic coefficient 7) of ground motion in April 2016, and then had over 200 deaths (directly and indirectly killed by the earthquakes) and 41-billion-USD damages. Another was the flood disaster by Typhoon No. 10 in 2016 over Tohoku and Hokkaido regions (the northeastern and northern Japan), which particularly caused great damages for agricultural and livestock products in the southern Hokkaido with poor river embankments for flood controls. We will hold an international symposium to share our experiences and lessons based on these severe disasters from Japan to the world. More catastrophic disasters caused by climate change and big earthquakes may occur in the future. To protect and reduce the disasters actively, it is necessary to collaborate and cooperate with a variety of government, academic and industrial organizations which work against disasters. This symposium will provide global thoughts and discussions among disaster experts and the people who are interested in, by thinking about earthquake and water-related disasters based upon experiences worldwide.

Organized by: World Federation of Engineering Organizations - Committee on Disaster Risk Management (WFEO-CDRM), Japan Federation of Engineering Societies (JFES), Japan Society of Civil Engineers (JSCE), Architectural Institute of Japan (AIJ), and Natural disaster information center of western Japan in Kyushu University

Supported by: Science Council of Japan (SCJ)

Date and Time: Wednesday, September 13, 2017, 09:00–13:00

Venue: Ito Campus, Kyushu University, 744 Motooka Nishi-ku, Fukuoka 819-0395, Japan.

Room: Inamori-hall A, Inamori Center

Maximum number of participants: 80 people

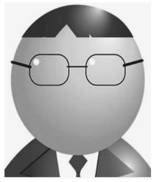
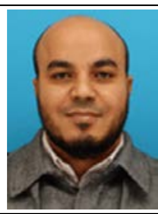
Admission: Free of charge, but you need to register at the reception desk (Inamori-hall A).
The registration will start at 08:40.

Language: English

(Note) This symposium is held as an international activity during the 72th annual conference of JSCE in 2017.

This symposium will provide the credits of JSCE Continuing Professional Development (CPD) program (JSCE17-0625, 3.3 credits).

Program

Time & item/speaker (affiliation)	Speaker’s present title	Country	
09:00 Opening remarks			
Toshimitsu Komatsu (Chair, WFEO-CDRM; Vice President, JFES; Emeritus Professor, Kyushu University)		Japan	
09:15 Earthquake disaster session			
Taiji Mazda (Professor, Kyushu University)	Overview of damage due to the 2016 Kumamoto Earthquake. (Page: 3 – 12)	Japan	
Fatih Sutcu (Assistant Professor, Istanbul Technical University in Turkey)	The recent developments in seismic isolation and response control technology and research in Turkey. (Page: 13 – 19)	Turkey	
Vilas Mujumdar (National Member, WFEO; Consulting Engineer; Vice chair, WFEO-CDRM)	A framework for resilient and sustainable communities. (Page: 20 – 29)	USA	
10:30~10:45 Short break			
10:45 Water & landslide disaster session			
Yasuyuki Shimizu (Professor, Hokkaido University; Chair, Committee on Hydraulic Engineering in JSCE)	Heavy rain-induced disasters in Hokkaido, August 2016. (Page: 30 – 43)	Japan	
Yukihiro Shimatani (Professor, Kyushu University)	Torrential rain-induced disasters in Northern Kyushu, July 2017 - preliminary report.	Japan	
Wen-Chi Lai (Professor, Taiwan National Cheng Kung University)	Hazard mapping and disaster management of large scale landslides in Taiwan. (Page: 44 – 51)	Taiwan China	
Mohamed Saber (Assistant professor, Assiut University in Egypt; Senior researcher, Kyoto University)	Wadi Flash Floods Integrated Management considering climate change for secured development in Egypt (WaFFIME). (Page: 52 – 62)	Egypt	
12:25 Closing Remarks			
Kenichi Tsukahara (Secretary, WFEO-CDRM; Professor, Kyushu University)		Japan	
12:30 End of the Program			

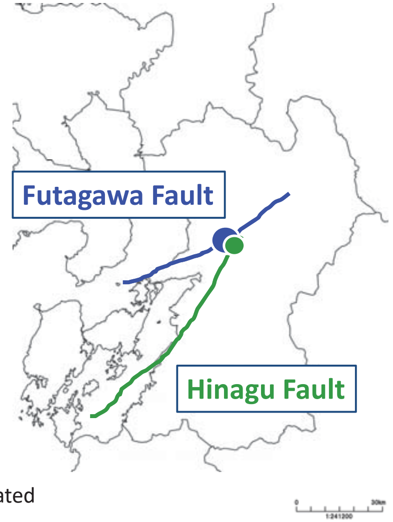
The 11th Joint International Symposium on Disaster Risk Management

Overview of damage due to the 2016 Kumamoto Earthquake

Department of Civil Engineering, Kyushu University
Taiji Mazda

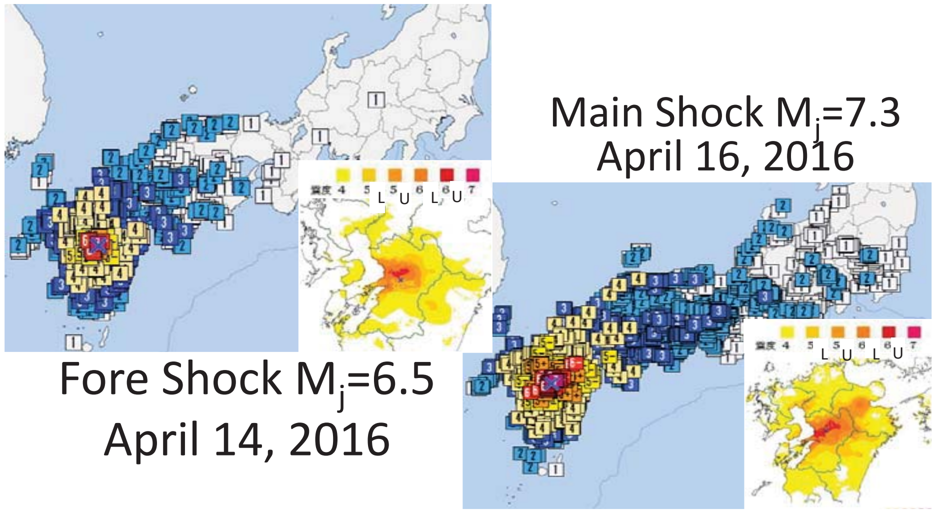
Double Strike

- Fore Shock(M_j=6.5,M_w=6.2) at 11 km depth, at 21:26 on 14th April 2016, a right lateral strike-slip fault on the northern part of the Hinagu Fault zone
- Main Shock (M_j=7.3,M_w=7.0) at 01:25 on 16th April 2016, on the Futagawa Fault zone.



M_j :the local magnitude defined and calculated by Japan Meteorological Agency (JMA)

Seismic Intensity of JMA



Japan Meteorological Agency (JMA)

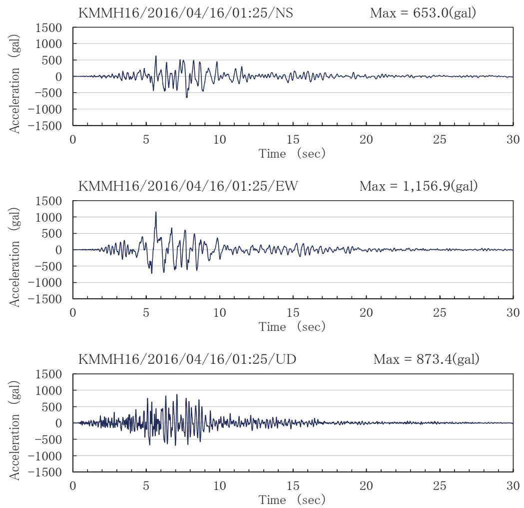
Ground motions of Main Shock in Mashiki

Maximum recorded Accelerations

NS:653gal

EW:1157gal

UD:873gal



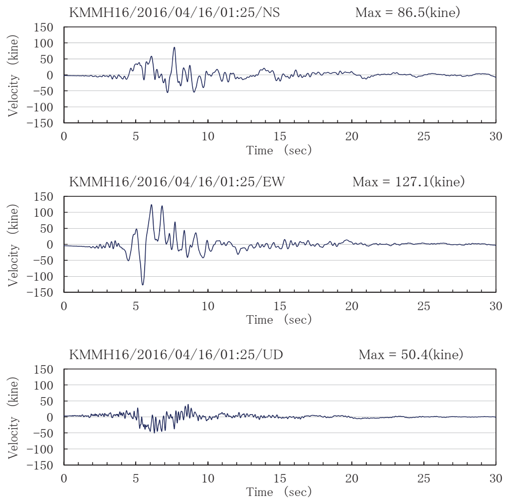
KiK-net Mashiki, NIED

Maximum Velocities

NS:86cm/sec

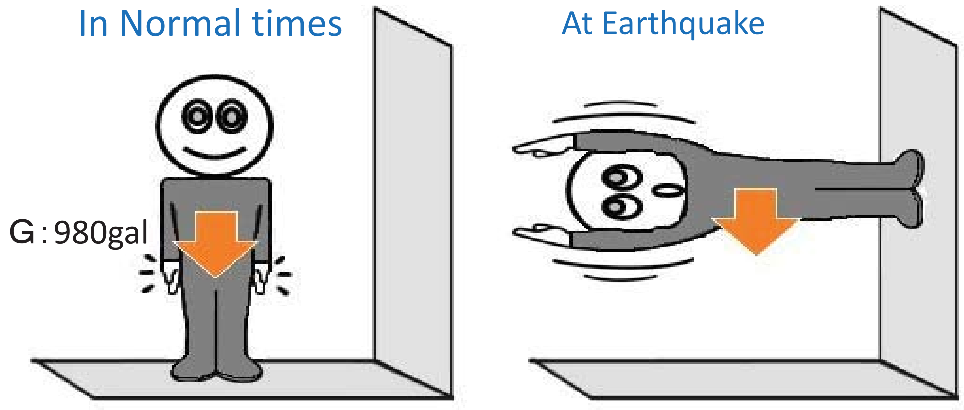
EW:127cm/sec

UD:50cm/sec



KiK-net Mashiki, NIED

Inertia



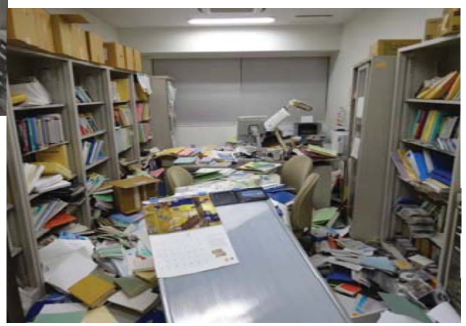
Gravity Acceleration vertically

Inertia force as same as weight horizontally

My Office 4th floor of 6-story RC Building

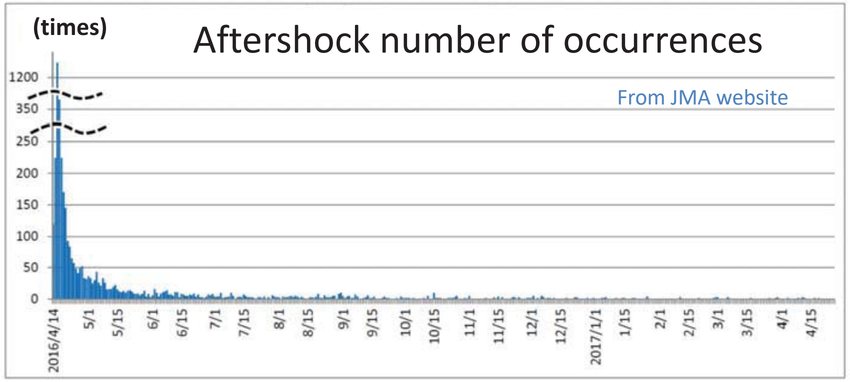
after Fore Shock

after Main Shock



Aftershock activity

- **Two times Intensity 7 of JMA**
- **Seven times over Intensity 6 Lower of JMA**
- **twenty three times over Intensity 5 Lower of JMA**
- **4305 times aftershocks until 26th April in 2017**



Outline of Damages until 18th April in 2017

Personal damages

- Killed: 220 persons (740 persons*)
- (Directly death: 50 persons,
- Related death: 170 persons)
- Severely injured:1131 persons
- Slightly injured: 1550 persons

Property damages

- Total collapse: 8,642 doors (15,300 doors*)
- Half collapse: 33,656 doors
- Partially damaged:147,402 doors

*Estimated value by regional disaster prevention plan

After Fore Shock

After Fore Shock

Mashiki Town

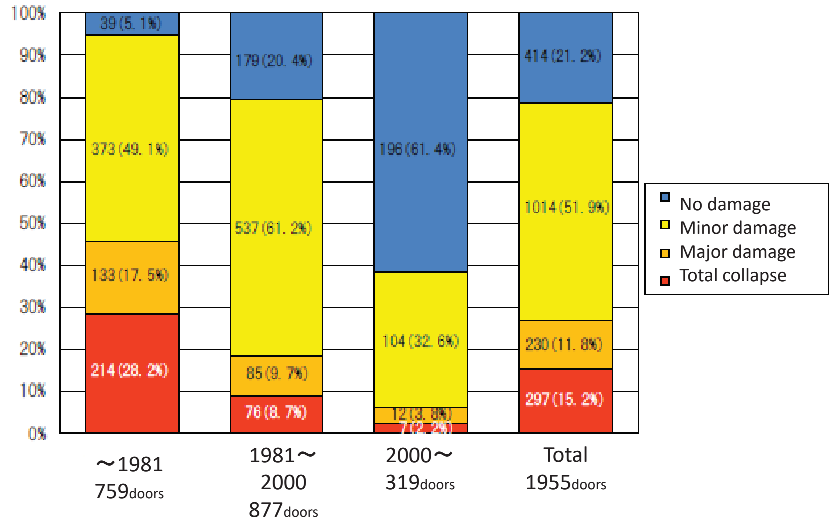
After Main Shock

Twenty Year Old House after Fore Shock

Mashiki Town

Twenty Year Old House after Main Shock

Mashiki Town



Damage type distribution depending on house age

BUILDING RESEARCH INSTITUTE HP

Damage of Expressway

Kiyamagawa bridge

17

Kiyamagawa bridge

18

Fryo first bridge

Kyushu Expressway

19

Namiyanagi bridge

20

Namiyanagi bridge

21

Tawarayama Tunnel

22

Tawarayama Tunnel

23

Tawarayama Oh-hashi Bridge

24

Tawarayama Oh-hashi Bridge

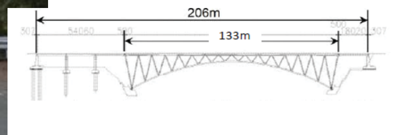
Prefectural Road 28

25

Prefectural Road 28

26

Collapse of Aso Oh-hashi Bridge



Minami Aso Village

27

Damage of student apartment

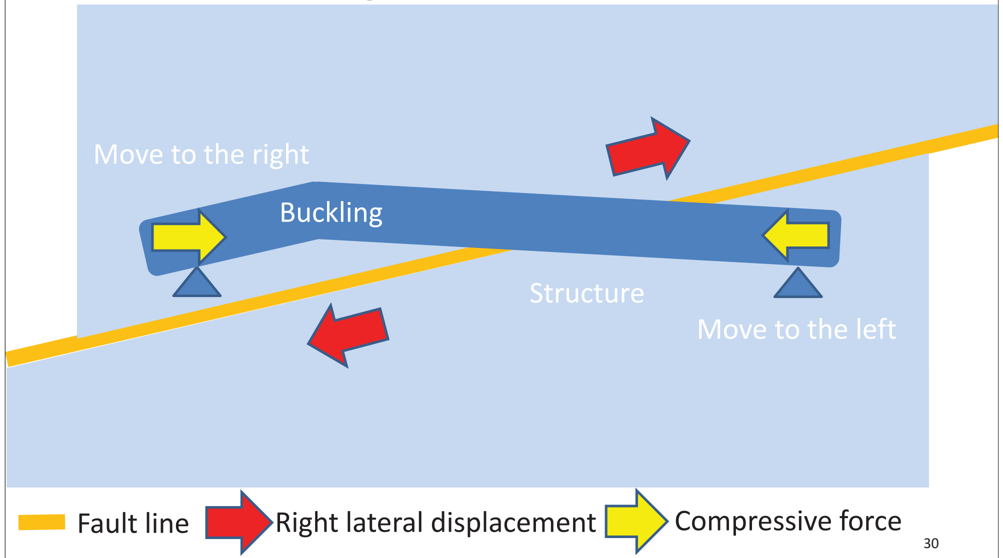
Minami Aso Village

28

Damage of student apartment

JSCE Quick Report 2016 Kumamoto Earthquake by M.Yoshimi

Compressive force induced by right-lateral fault



Tawarayama Oh-hashi Bridge

Buckling of girder

Evidence of compressive force

Raised gutter cover

Crashed gutter cover

Prefectural Road 28

Liquefaction

Liquefaction

Liquefaction

Kumamoto City, Chikami

Damage of Kumamoto Castle

Damage of stonewall

JSCE West Branch Report 37

Damage of Kumamoto Castle

JSCE West Branch Report 38

Overview of earthquake and damage

- Twice Seismic Intensity 7
- Large aftershock and frequent aftershock
- Damage to structures designed by recent specifications
- Ground deformation induced by active fault
- Many liquefaction

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Thank you for your kind attention

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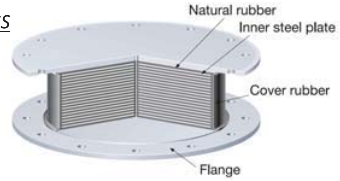
JSCE 11th Joint International Symposium
on Disaster Risk Management
2017.09.13

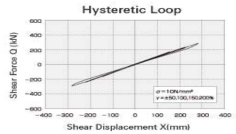
THE RECENT DEVELOPMENTS IN SEISMIC ISOLATION AND RESPONSE CONTROL TECHNOLOGY AND RESEARCH IN TURKEY.

Asst. Prof. Dr. Fatih SUTCU
Istanbul Technical University
Earthquake Engineering & Disaster Management Institute

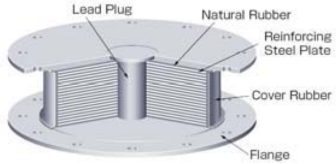
RUBBER SEISMIC ISOLATOR BEARINGS

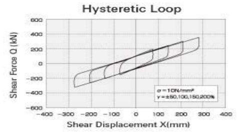
NATURAL RUBBER BEARING - NRB



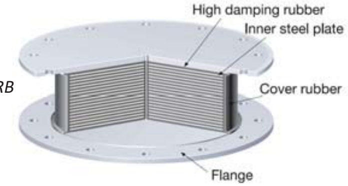


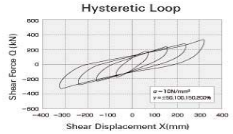
LEAD-PLUG RUBBER BEARING - LRB





HIGH DAMPING RUBBER BEARING - HDRB






VISCOUS OIL-DAMPER


LEAD DAMPER

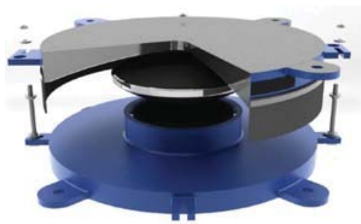

STEEL DAMPER

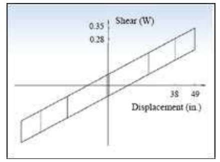

STEEL DAMPER

Courtesy of Prof Toru Takeuchi

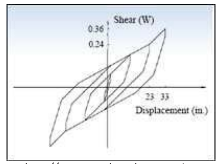
FRICTION PENDULUM BEARINGS

DOUBLE PENDULUM BEARING

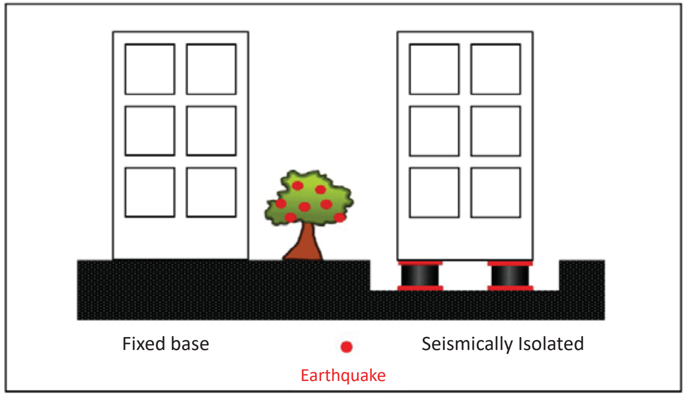


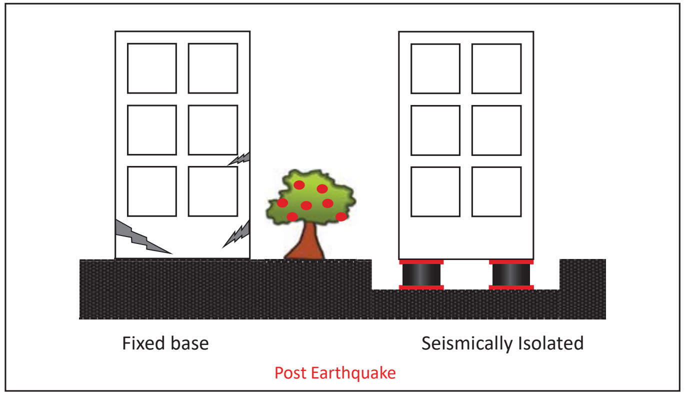


TRIPLE PENDULUM BEARING



http://www.earthquakeprotection.com





Yönetmelikler / *Design Codes*

2009 Turkish Association of Seismic Isolation: Seismic Isolation Design Code For Buildings

2013 Turkish Ministry of Health – Standards for Design and Construction of Seismically Isolated Medical Buildings

2017 New Seismic Code including Seismically Isolated Building Design Chapter: Under progress.

Table 1. Comparison of the essential elements of the codes

	Japan	ASCE 7-10	EU (EC8-Italy)	TR (Draft) Code
Design methods	No Calc. /ELFM /NLTHA	ELFM / RSA / NLTHA	ELFM / RSA / NLTHA	ELFM / RSA / NLTHA
Return Period (year)	(50/500 Estimated)	MCE (2475 or ε=1)	475	475/2475
Design Spectra (IS/BLD)	DE/DE	MCE/DE=2/3MCE	DE/DE	10%-50 / 2%-50
Spectrum	Dominant component	Max.Rot.Comp	Dominant component	TBD
Importance factor	Yes	No	Yes (<=1.4)	No
Vertical load	Included	Included	Included	Included
Ageing/dispersion	1.2	From tests	From tests	From tests
Safety factor on Isolation capacity	Elastomeric = 0.8 – sliding/friction = 0.9	Implicit in the MCE design level	1.2 (Reliability Factor)	Implicit in the 2%-50 design level
Torsion in ELFM	1.1	Calculated	Calculated	Calculated
	Max ecc. 3% L	No limit	Max ecc. 2.5% L	Max ecc. 5% L
BLD requirements	Elastic	low ductile (max R=2)	low ductile (max R=1.5)	low ductile (max R=2)
	V_{base} = 1.3 V_{ELFM}	V_{base} = 1.0 $V_{ELFM,DE}$	V_{base} = 1.0 V_{ELFM}	V_{base} = 1.0 $V_{ELFM,DE}$
Modeling	Simple 2D, even for NLTHA	2D for ELFM, otherwise 3D	2D for ELFM, otherwise 3D	2D for ELFM, otherwise 3D
ELFM basic conditions	T_2 > 2.5s, F_y > 0.03W	More stringent	More stringent	More stringent
Drift Ratio	1:200 / 1:50	1:50	1:200	1:200

From Prof. Mustafa Erdik's 14WCSIpaper

Yönetmelikler / *Design Codes*

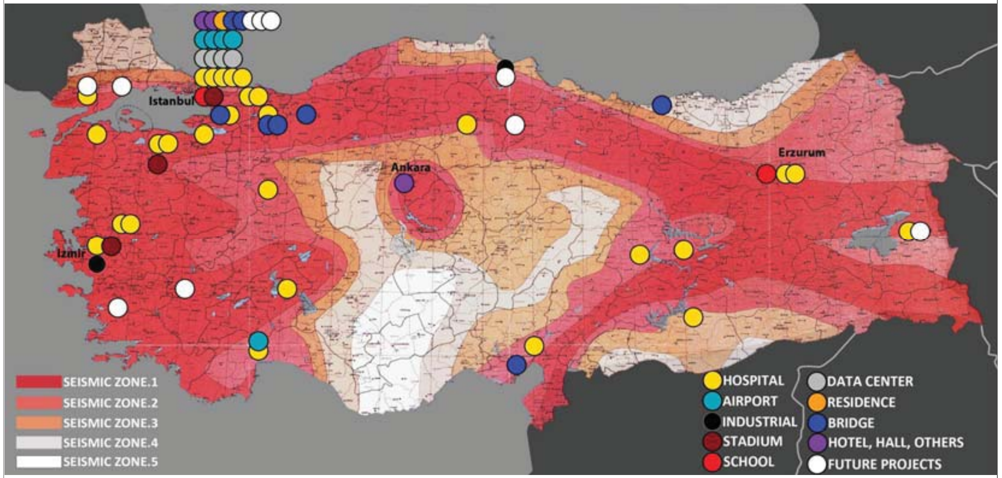
Table 2. Comparison of the limitations for Equivalent Force Method

Code	Japan	ASCE 7-10	Italy (EC-8)	TR Draft Code
Limitation on site seismicity	—	S_1 < 0.6g	—	$S_{MR}(1)$ < 0.6g
Limitation on soil class	1,2	A, B, C, D	---	TBD
Maximum plan dimension	—	—	50m	----
Maximum height of	60m	20m	20m	20m
Maximum number of stories	—	4	5	----
Location of devices	Base only	---	—	----
Maximum mass-stiffness centers eccentricity	3%	---	3%	5%
K_v/K_e	---	---	≥ 800	——
Tension in isolator	Not allowed	Allowed	Not Allowed	Not Allowed
Yield strength	> 0.03W	---	—	---
Period range of T_e	T_2 > 2.5s	$3T_f$ - 3.0s	$3T_f$ - 3.0s	$3T_f$ - 3.0s
Maximum value of T_v	—	—	< 0.1s	< 0.1s

W: total weight above the isolation interface
T_f: natural period of the fixed-base super-structure.
T_2: period of the isolation system considering only the stiffness of rubber bearings.
T_e: equivalent period of the isolation system (Design Earthquake Level).
T_V: period of the isolation system in vertical direction

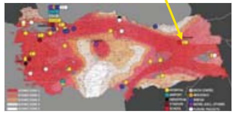
From Prof. Mustafa Erdik's 14WCSIpaper

Uygulamalar/Applications



Erzurum-city
Healthcare Campus

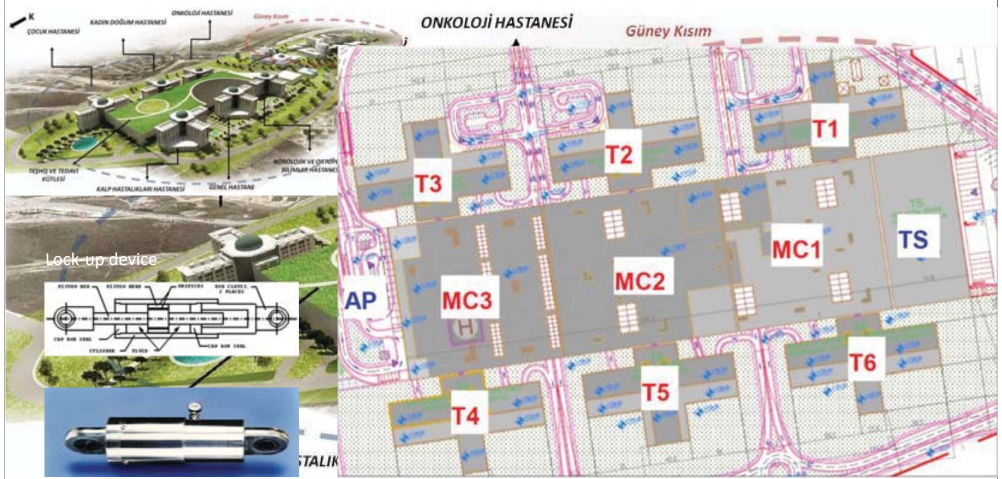
1250 Isolators



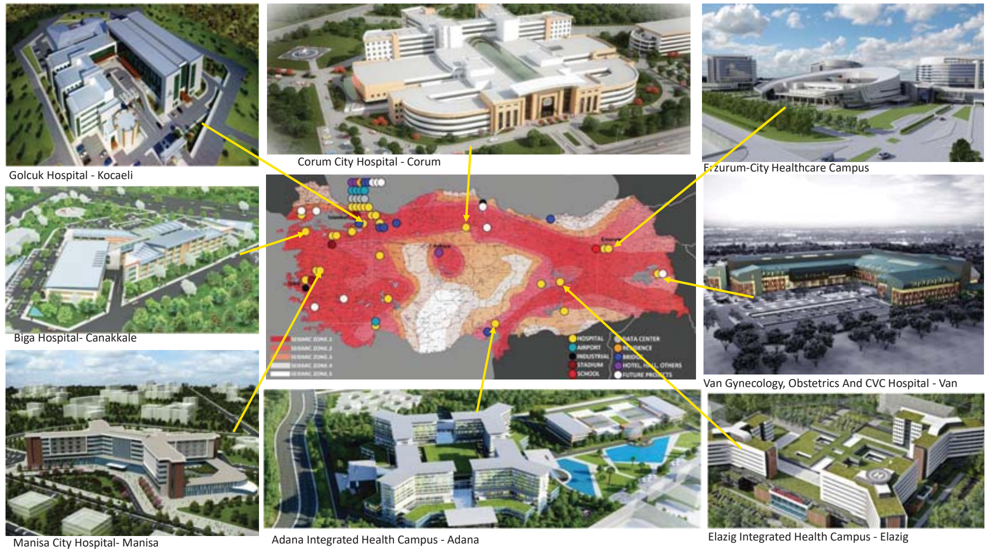
Okmeydani Training and
Research Hospital - Istanbul

Okmeydani Training and
Research Hospital – Istanbul
500+ Isolators

Ikitelli Healthcare Campus – Istanbul, 2200 Isolators



http://taylordevices.com/



SI Residence – Silivri/Istanbul

SI Retrofit of Viaduct in Istanbul

Izmit Bay Suspension Bridge

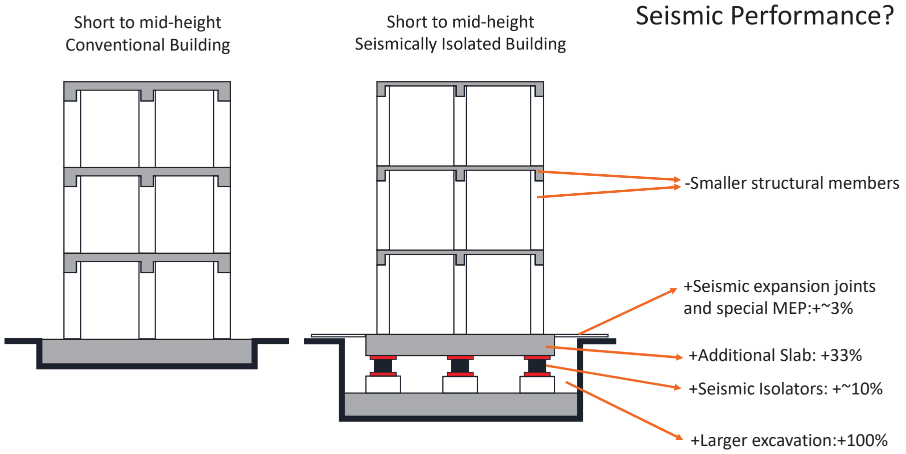
MEP&SI relation / challanges

No extension margin in cables.

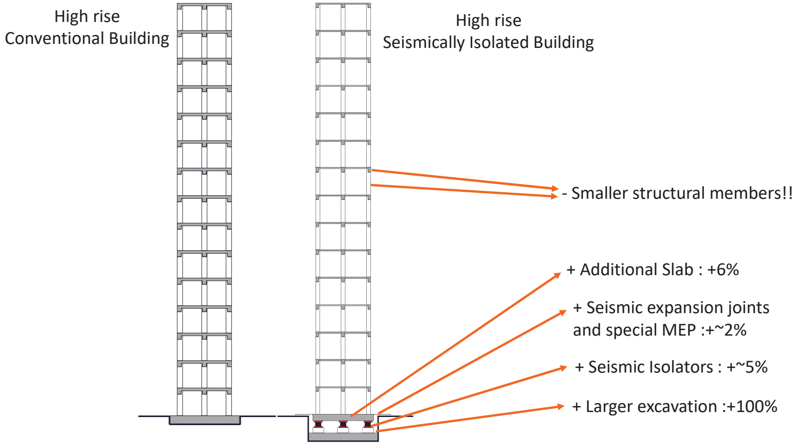
MEP&SI relation / flexible joints, expansion joints

Courtesy of Dr Yozo Shinozaki

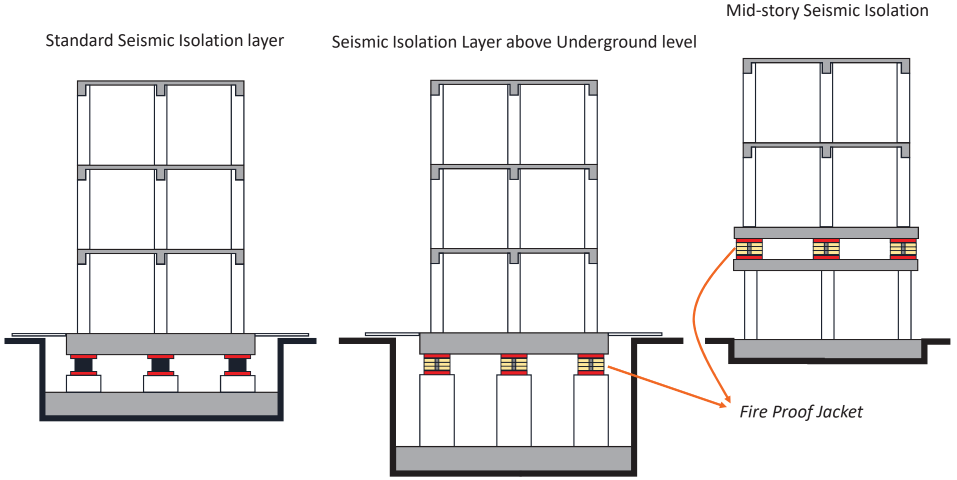
Contribution of SI to the construction cost



Contribution of SI to the construction cost



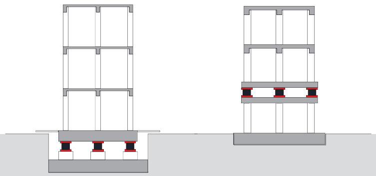
SI Application Layout



Factors Influencing SI Cost

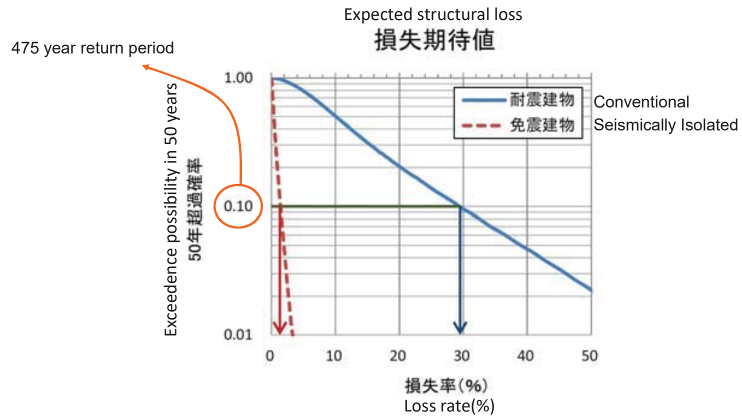
- Seismic Isolation Type
  Isolator type, Isolator or Isolator + damper.

- SI Application Layout
  Isolation layer or mid-story isolation



- Number of Stories
  Low-rise, mid-rise or high-rise building
- Seismicity
  Seismic intensity and frequency
- Function of the Building
  Residence, school, communication building, hospital: Building importance factor
- Expected Seismic Performance
  Life safety, immediate occupancy, uninterrupted business

Comparison of SI and conventional buildings seismic loss

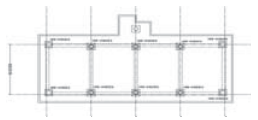


Courtesy of JSSI

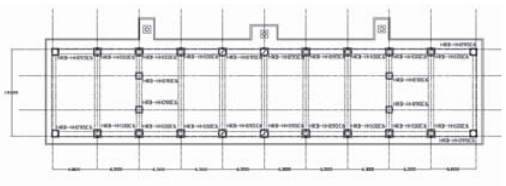
Life Cycle Cost (LCC) Comparison of SI and conventional buildings

	5 Story Model 5階建モデル	12 Story Model 12階建モデル
Base area 建築面積	192.0m^2	832.0m^2
Total area 延床面積	960.0m^2	9984.0m^2
Story number 階数	5	12
Building height 建物高さ	15.0m	36.0m
Structure type 構造種別	RC造	RC造
Structural period (Approx) 建物周期(略算)	0.300s 0.300秒	0.720s 0.720秒

5 Story Model
5階建モデル

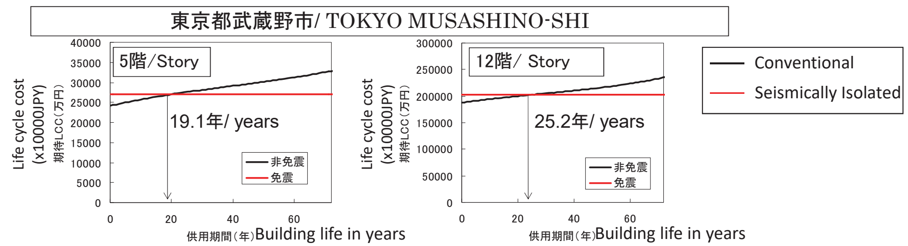


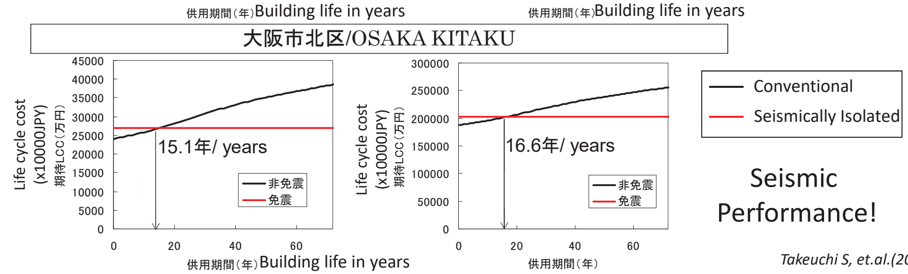
12 Story Model
12階建モデル



Takeuchi S, et.al.(2007)

Life Cycle Cost (LCC) Comparison of SI and conventional buildings



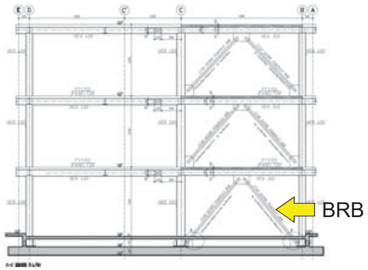


Seismic Performance!

Takeuchi S, et.al.(2007)

Response Control applications in Turkey

Buckling Restrained Brace (BRB) application in Istanbul Technical University



Response Control applications in Turkey

Buckling Restrained Brace (BRB) application in Istanbul Technical University

Response Control applications in Turkey

Buckling Restrained Brace (BRB) application in Alliance Tower in Istanbul. BRBs used as outrigger braces.

ekkürler

Thank You

とうもありがとう

A Framework for Resilient and Sustainable Communities

Vilas Mujumdar, P.E., S.E.,
Consulting Engineer
Vienna, VA
USA

11th Joint International Symposium
Disaster Risk Management

Kyushu University,
Fukuoka
Japan

Sept. 13, 2017

A Framework for Resilient and Sustainable Communities

- **Outline of Presentation**
- 1. Natural Hazards data
- 2. Resiliency – definition
- 3. Sustainability – definition
- 4. Community context
- 5. Attributes
  - a. Resiliency
  - b. Sustainability
- 6. Common Attributes
- 7. Summary and Conclusions

Natural Hazards

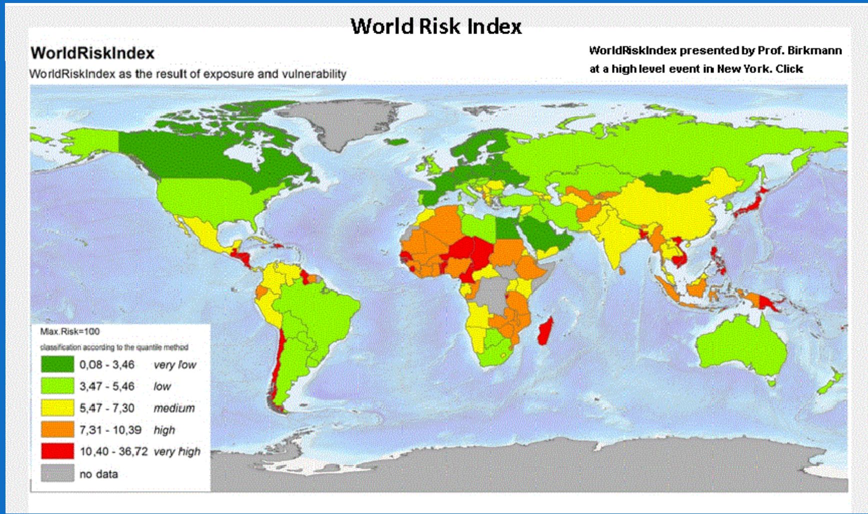
Climate Change Example

Increased frequency of heavy rains and earthquake occurrences, e.g. 2004 Niigata-Chuetsu earthquake after a typhoon in Japan
- caused 12 large-scale landslides amounting to displacement of more than one million cubic meters of earth-

In the US, expenditure on Dykes alone - $12 B annually- NAS-2014

- *Global Sea Level Rise > 5 in. by 2030, more uncertainty but also Increase in frequency of flooding, tidal surges*
- Without adaptive measures – Costs $2 -11 T annually by 2100

Natural Hazards Risk – 2016
(based on Vulnerability and Exposure)



Courtesy- IRDI International

INFORM - Risk Model

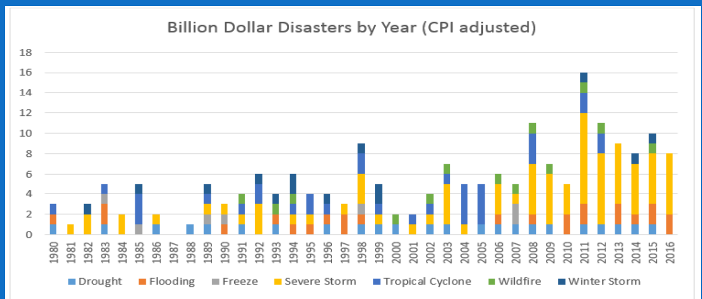
Japan	Value	Rank
INFORM Risk	2	156
Hazard & Exposure	5.7	37
Vulnerability	0.9	184
Lack of Coping Capacity	1.5	183

USA	Value	Rank
INFORM Risk	3.1	110
Hazard & Exposure	5.8	36
Vulnerability	2.3	117
Lack of Coping Capacity	2.2	164

Risk = Hazard & Exposure$^{1/3}$ x Vulnerability$^{1/3}$ x Lack of coping capacity$^{1/3}$

The INFORM model adopts the three aspects of vulnerability reflected in the UNISDR definition. The aspects of *physical exposure and physical vulnerability are integrated in the hazard & exposure dimension*, the aspect of *fragility of the socio-economic system becomes INFORM's vulnerability* dimension while *lack of resilience to cope and recover is treated under the lack of coping capacity dimension*.

Major Natural Disasters - World



Source- Google maps

- **Globally between 2000 and 2012, severe storms, droughts, tornadoes, earthquakes, floods, hail storms, wildfires, and hurricanes disrupted the lives of 2.9 billion people and caused $1.7 Trillion in damage.**
- **Earthquakes killed the most people, an average of 50,184 people a year (2000 to 2008)**
- **Floods, however, affected the largest number of people – an average of 99 million people a year.**

Natural Hazards – Global Annual Data (2005-2014)

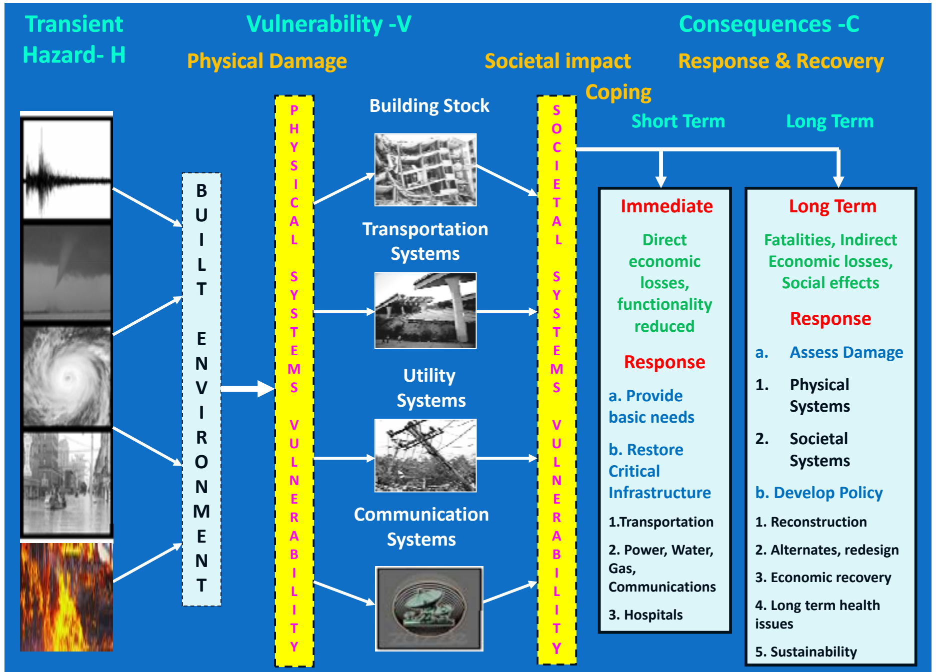
❖ **Economic Losses – $180 B/yr – 10 year average**

(Annual loss of Consumption > $500 B – World Bank -2016)

1. Number of events - 870
2. Fatalities – 68,000 +
3. Floods – 35% – 40 %
4. Severe storms and Typhoons - 30%
5. Earthquakes, Tsunamis, and Landslides – 20%
6. Fires – 10%

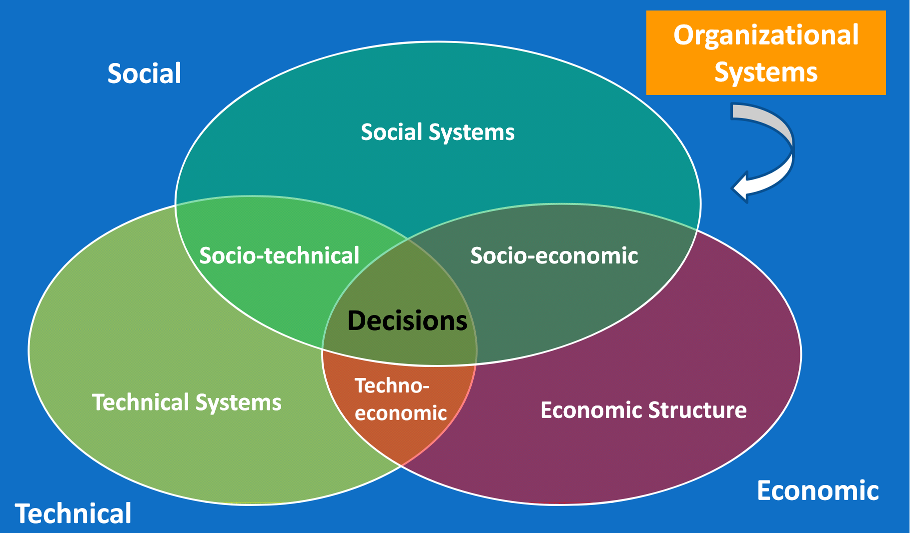
World Bank estimated that during 1990-2000, natural disasters resulted in damage that is between 2% and 15% of an exposed country's annual GDP.

In 2014 - $110 B in economic damages



COMMUNITY
an
INTEGRATED SYSTEM

Community – A Coupled Complex System



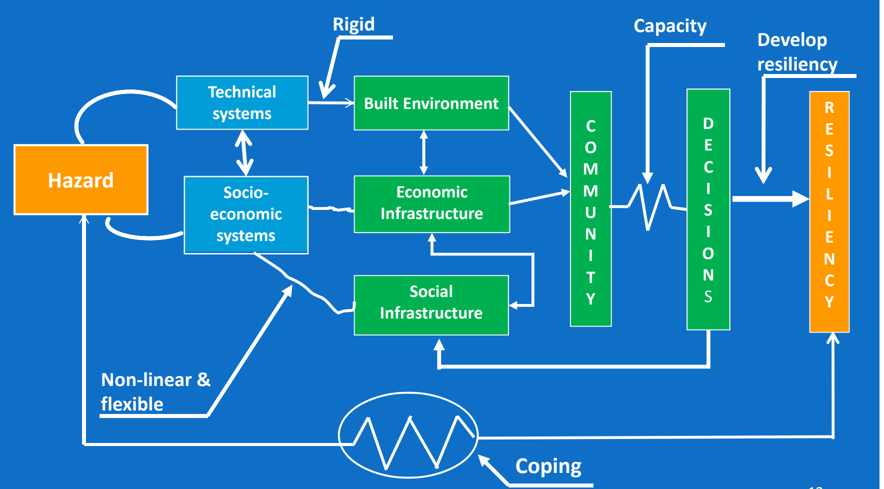
Integrated Community System

Definition

- An *Integrated system* comprises of technical, and socio-economic subsystems that are interdependent and interact coherently and synergistically within organizational structure constraint, *forming a unified whole* to achieve a beneficial purpose for the community.

Linkages and feedback loops are extremely important, and determine the overall system behavior

Linkages - Sub-systems



RESILIENCY

↓

Hazards – *Natural & Man-made*

Resiliency - Definitions

Specific to Hazards

"The ability to prepare and plan for, absorb, recover from or more successfully adapt to actual or potential adverse events" **(NAE)**

"Ability of a structure to withstand events (like fire explosion, impact) or consequence of human errors, without being damaged disproportionately to the cause" (*ISO 22114*)

Resiliency 》 [**Reliability**, **Robustness**, **Redundancy**]

Community Resiliency is inter-disciplinary and dimensions for *physical systems* and *socio-economic systems are different*

Community Resiliency - Components

Community Resiliency is composed of *built environment, economic system and societal system* as components that are interdependent

Community Resiliency - $R_C = \sum R_{B,} R_{E,} R_S \mid F_A$

- R_C = Total Community Resiliency
- R_B = Resiliency of Built Environment
- R_E = Economic system Resiliency
- R_S = Societal systems Resiliency
- F_A = Acceptable Functionality

Resiliency can be measured by *time required to restore* :

- **Built environment functionality**
- **Economic activity, and**
- **Services for normal functioning**

Community decides acceptable levels of functionality of various systems

Quantifying Resiliency in numerical terms is difficult, need both Quantitative and Qualitative approaches

Community Resiliency - Attributes

❖ MCEER- USA developed four attributes of resiliency:

1. **Robustness** - **Well –conceived, constructed , and managed systems (able to survive disruption with minimal impact) – applies to all systems but *mostly* to physical systems**
2. **Redundancy** – **Spare Capacity purposively created to accommodate disruption - applies to physical systems *mostly***
3. **Resourcefulness** – **Adoptive alternate ways to use resources applies to socio-economic systems**
4. **Rapidity** – **Ability to recover quickly after disruption - applies to socio-economic systems *mostly***

Additional Attributes ⇨ **Systems-level, Inclusive, and Capacity Building**

For a community, resilience, R, can be measured as the expected loss in quality (Q) (probability of failure) over the time to recovery, $t_1 - t_0$.

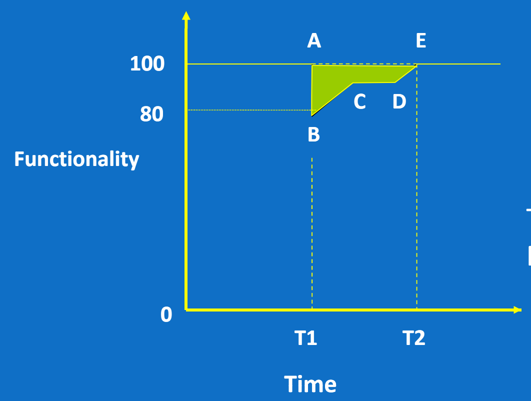
Thus, mathematically, R can be defined as:

$$R = \int_{t_0}^{t_1} [100 - Q(t)]dt$$

Measure of Resiliency

(Area under ABCDE)

Smaller the area under curve, the greater the resiliency



B = Event Occurred
E = Full Recovery

$T_2 - T_1$ = Rate of Recovery (Rapidity)

Building Community Capacity

A. Prior to major hazard event

Mitigation
- a. Condition Assessment of infrastructure
- b. Economic incentives to make critical systems remain functional during an event

B. During major hazard event

Response
- a. Societal Preparedness
- b. Timeliness – efficiency
- c. Resource availability
- d. Resource Mobilization

- Community education on Risk
- Regular Drills
- Socio-Psycho assistance

C. After major hazard event

Recovery
- a. Strong economy – private industry
- b. Govt. Programs for Reconstruction

RESILIENCY

Impact Comparison – Three Major Earthquakes

Impact \ Place	Haiti-2010	Chile-2010	New Zealand 2010, 2011
Earthquake magnitude	7.0	8.8	7.1 & 6.3
Dead	316,000	723	184
Wounded	300,000	500	50
Economic Loss (%of GDP)	8 B- USD (100)	30 B- USD (18)	24 B- USD (20)
Local time	Afternoon	Early Morning	Mid-day
State of Country (UN)	Low Developing	High Developing	Developed
Rank in human Development (UN)	**148**	**45**	**3**

Community Resiliency Comparison
Three Major Earthquakes

Resiliency \ Place	Haiti 2010	Chile 2010	New Zealand 2011,2011
R_B	Very Low	Medium/High	High
R_E	Very Low	Medium	High
R_S	Very Low	Low/Medium	High/Very High
Functionality (F_A)	Poor	Average	Average/Good
Overall Resiliency R_C	Very Low	Medium	High

Sustainable Communities

↓

Resource Utilization, Long-term Costs, Circular Economy, Environment, Equality, Future Generations

America's Infrastructure Grading - 2017

Report Card

Category	Grade	Category	Grade
Aviation	D	Parks and Recreation	D+
Bridges	C+	Ports	C+
Dams	D	Rail	B
Drinking Water	D	Roads	D
Energy	D+	Schools	D+
Hazardous Waste	D+	Solid Waste	C+
Inland Waterways	D	Transit	D-
Levees	D	Wastewater	D+

Methodology

Each category was evaluated on the basis of capacity, condition, funding, future need, operation and maintenance, public safety and resilience.

- A = Exceptional
- B = Good
- C = Mediocre
- D = Poor
- F = Failing

Overall D+

Estimated Investment needed (2016-2025)
$4.59 T- Funding gap $2 T

Source -ASCE

Infrastructure Functionality

- All infrastructure must restore adequate functionality quickly after a disaster
- To preserve the functionality *complex interaction of all components of a system* at local, Regional, and international level must be understood

To improve the preparedness and resilience of federal agencies:

- Engaged and strong partnerships and information sharing at all levels of government
- Risk-informed decision-making
- Adaptive learning
- Preparedness planning

Executive Order 13653, November 1, 2013

Similar proactive effort in the private sector is essential

Sustainability

Definitions

Classic Dictionary Definition:
" A state which is maintained at a certain level for a long time (indefinitely)"

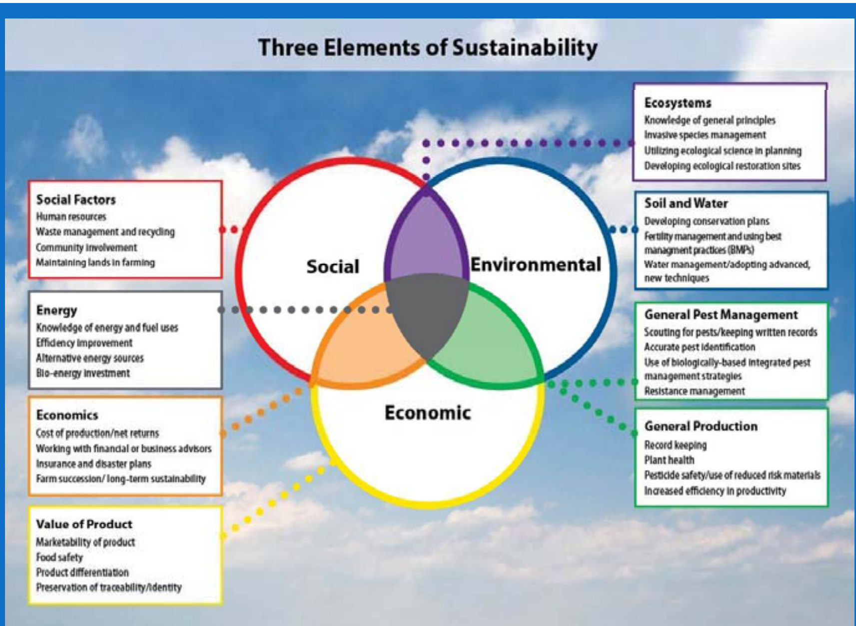
In the Context of Sustainable Development:
" Developing economic systems that go on for ever"

Most commonly accepted

"Sustainable development is the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs". *(Brundtland Commission -1987)*

Three main pillars of sustainable development:

- *Economic growth - Viable*
- *Environmental - Consciousness,* and
- *Social equality - Acceptance*



Courtesy- Google

Sustainability

International Standards Organization (ISO)

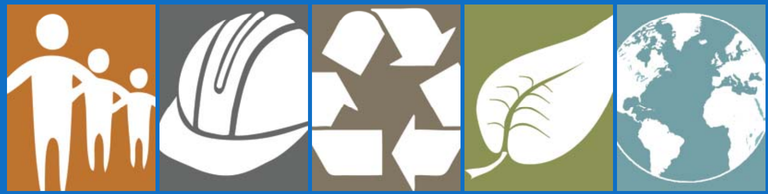
ISO 14001, generally accepts the Brundtland Commission's definition of sustainable development . It provides a foundation for creating a *complete sustainable system* and identifies four attributes:

1. Awareness of the impact of actions on the environment,
2. Acceptance of responsibility for those impacts,
3. The expectation that harmful impacts will be reduced or eliminated,
4. The placement of responsibility for environmental impacts upon all members of the community.

In summary,

Where affordable and reliable resources support the socio-economic and environmental needs of a growing population

THE ENVISION™ RATING SYSTEM



Source- ASCE

THE NEED FOR ENVISION™

Envision™ is Uniquely Qualified to Address America's Infrastructure

- Envision™ applies to all civil infrastructure (roads, bridges, pipelines, railways, airports, dams, levees, landfills, water treatment systems, and other civil infrastructure that make up the built environment).
- Addresses design, planning, construction and maintenance
- Applicable at any point in an infrastructure project's life cycle
- Speaks to the triple bottom line: social, economic and environmental goals
- Designed to keep pace with a changing concept of sustainability

Source -ASCE

What Types Of Infrastructure Will Envision™ Rate?

ENERGY	WATER	WASTE	TRANSPORT	LANDSCAPE	INFORMATION
Geothermal	Potable water distribution	Solid waste	Airports	Public Realm	Telecommunications
Hydroelectric	Capture/Storage	Recycling	Roads	Parks	Internet
Nuclear	Water Reuse	Hazardous Waste	Highways	Ecosystem Services	Phones
Coal	Storm Water	Collection & Transfer	Bikes		Satellites
Natural Gas	Management		Pedestrians		Data Centers
Oil/Refinery	Flood Control		Railways		Sensors
Wind			Public Transit		
Solar			Ports		
Biomass			Waterways		

Source -ASCE

UN Sustainable Development Goals (SDGs)

The 17 SDGs and 169 targets lie at the heart of the newly-agreed development framework ***(UN 2015)***

- **The key issues are:**
  - ***To eradicate poverty and hunger in all forms,***
  - ***To combat inequalities within and among countries,***
  - ***To build peaceful, just and inclusive societies,***
  - ***To protect human rights and promote gender equality and the empowerment of women and girls, and***
  - ***To ensure the lasting protection of the planet and its natural resources by 2030***

Sustainability Goals

Goal 11

11 SUSTAINABLE CITIES AND COMMUNITIES

Make Cities and human settlements inclusive, safe, resilient and sustainable

Create Policies, Develop plans, and Actions & Processes for

Resource Utilization, Long-term Costs, Circular Economy, Environment, Equality, Future Generations

Sustainability

NEEDS

Raw material and energy inputs, Feasible Engineering Solutions, Cross-sectoral flows and linkages, Effective Policy, Education and Research

Traditional Linear Economy

Make,
Use,
Dispose

Circular Economy

- Keep resources in use as long as possible
- Extract maximum value whilst in use
- Recover and regenerate products and materials at the end of each service life

Resilience and Sustainability

Common Considerations

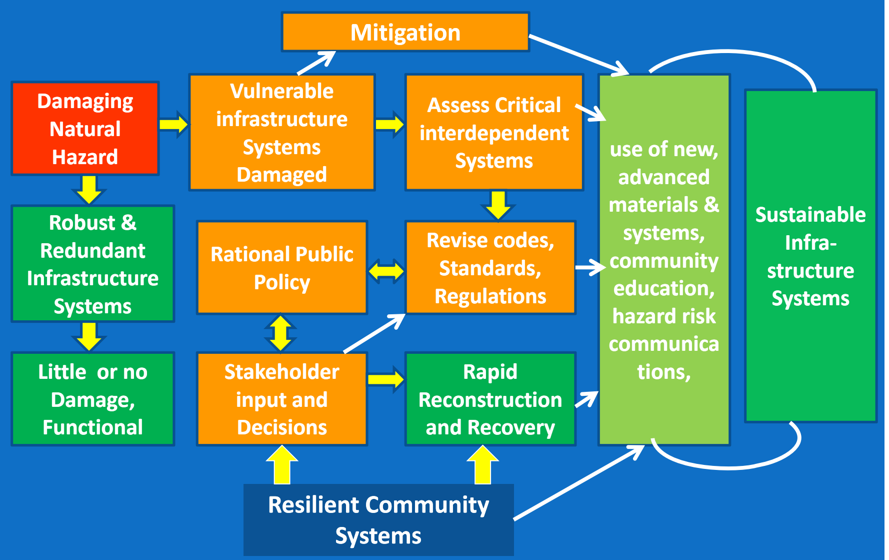
- Community works as an integrated system comprising technical, social and economic system within the constraint of Organizational structure
- Systems are interdependent and joint behavior determines the overall behavior of the community system
- Environment affects both hazards and long-term sustainability, community must be flexible to adopt to climate changes
- Infrastructure systems need to be operational for community functionality and thus resilient
- All community systems need to come back to acceptable functionality quickly after effects of a damaging hazard
- All stakeholders need to act together for community response, future strategic planning planning, and resource utilization
- Public policy development and implementation is critical
- Governance structure needs to be clear, efficient and responsive

Resilience and Sustainability

Common Measurable Attributes - Resilience and Sustainability

Environment (Ecology - Protection)	Economy (Economic well - being)	Equality (Social fairness)
Air Quality	Employment Level	Access to Health Systems
Water Pollution	Poverty Rate	Housing affordability and Rent structure
Safe Drinking Water	Home ownership	Meeting Educational needs
Number of Polluted sites	Transportation Networks	Graduation Rates
Climate Change Impacts	Electric Power Systems	Crime Rates
Urban heat island effect	Water Systems	Levels of Public Service
Congestion from people and vehicles	Wastewater Systems	Effective Governance
Sustainable use of Renewable resources	Natural Gas and Oil Systems	Institutional capacity
Minimizing use of non-renewable resources	Communications Network	Social Relationships among individuals and norms
Preserves- Open space	Financial Institutions	Embracing innovation and changes

Hazard to Sustainable Infrastructure systems



Conclusions

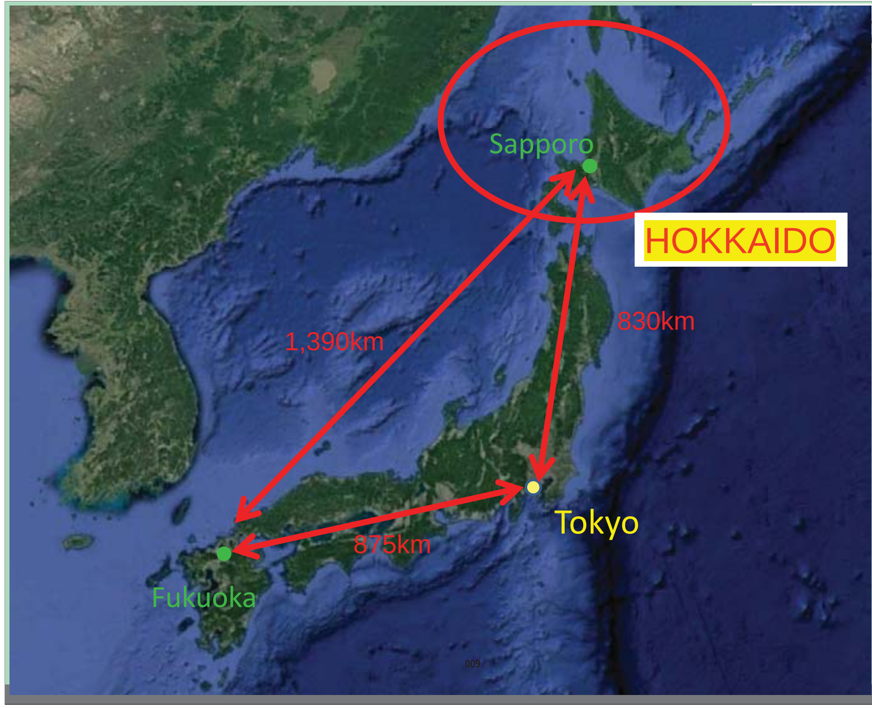
1. For both Community resilience and Sustainability, trans-disciplinary approaches are required
2. Although, resilience and sustainability have different attributes and dimensions, commonalities exits to make communities better
3. Pre-existing conditions and hazards determine the vulnerability of overall community systems
4. Operations of various systems play a critical role in determining system resiliency
5. The overall system resiliency can be graded on a *qualitative scale* as assigning numerical score to each component of resiliency is difficult
6. Proactive actions to create a *circular economy structure* is required
7. Public Policy is important for long term investment in the community to reduce disaster impact
8. Trust must be developed between authorities and the public

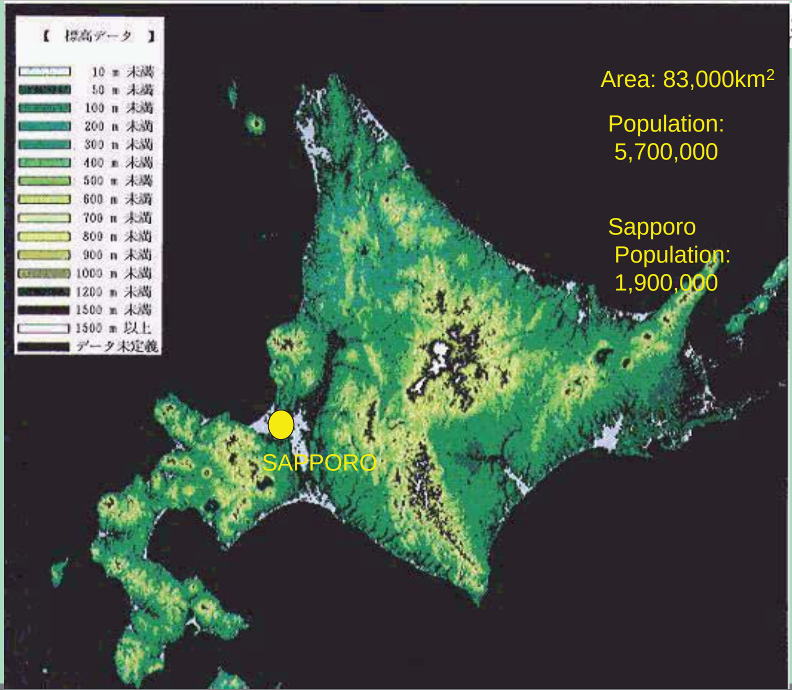
THANK YOU

Heavy rain-induced disasters in Hokkaido, August 2016.

Yasuyuki Shimizu

Graduate School of Engineering, Hokkaido Univ., Japan

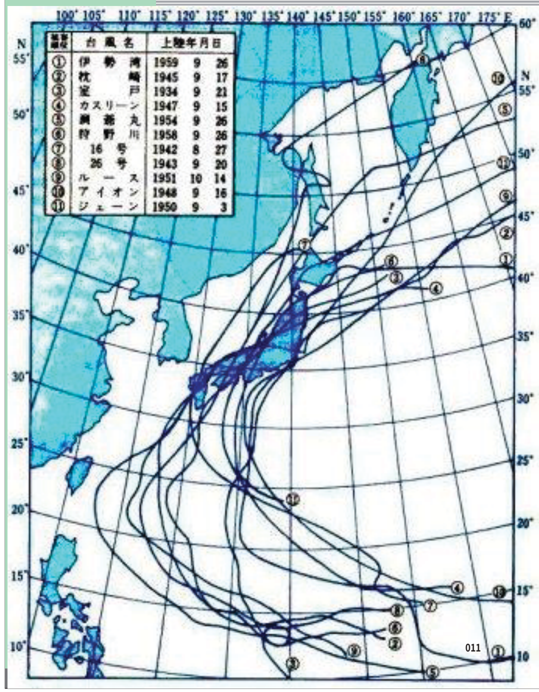




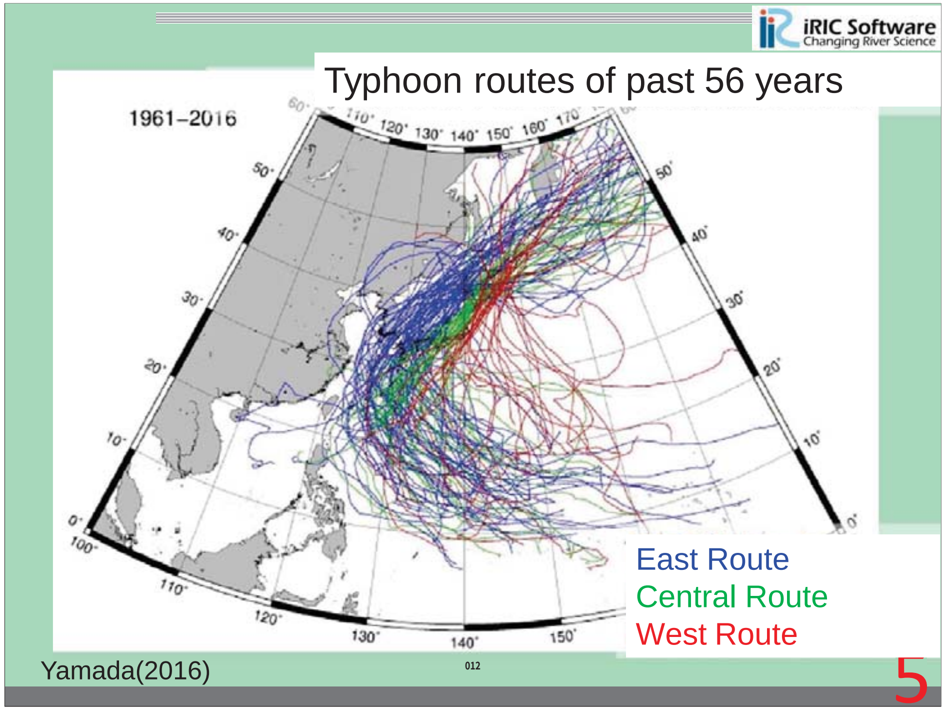
Area: 83,000km^2

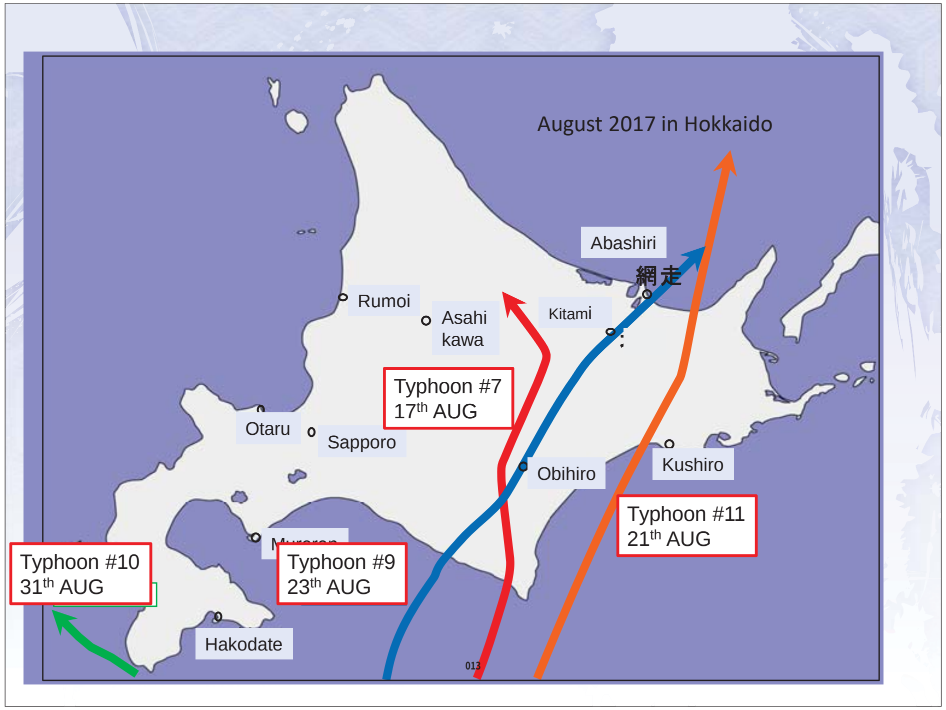
Population: 5,700,000

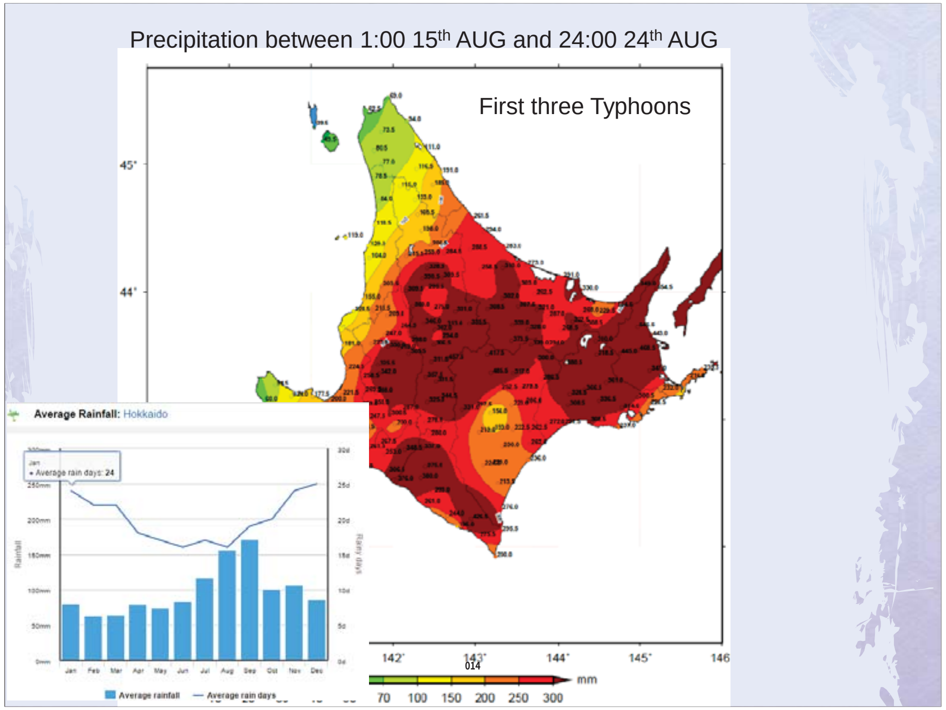
Sapporo Population: 1,900,000



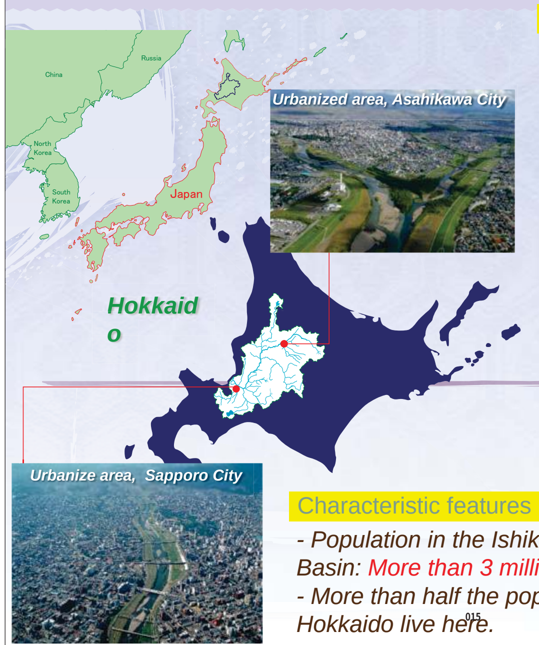
Huge typhoons attacked Japan in the past 70 years







1. The Ishikari River Basin today and its importance



Outline of the Ishikari River

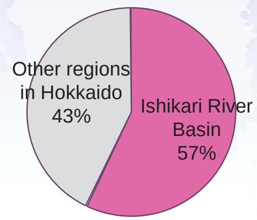
- Catchment area: 14,330 km²
- Main channel length: 268 km

Rank	River	Main Prefecture	Catchment area (km²)
1	Tone	Chiba etc.	16,840
2	Ishikari	Hokkaido	14,330
3	Shinano	Niigata etc.	11,900
4	Kitakami	Miyagi	10,150
5	Kiso	Mie	9,100
6	Tokachi	Hokkaido	9,010
7	Yodo	Osaka	8,240
8	Agano	Niigata	7,710
9	Mogami	Yamagata	7,040
10	Teshio	Hokkaido	5,590

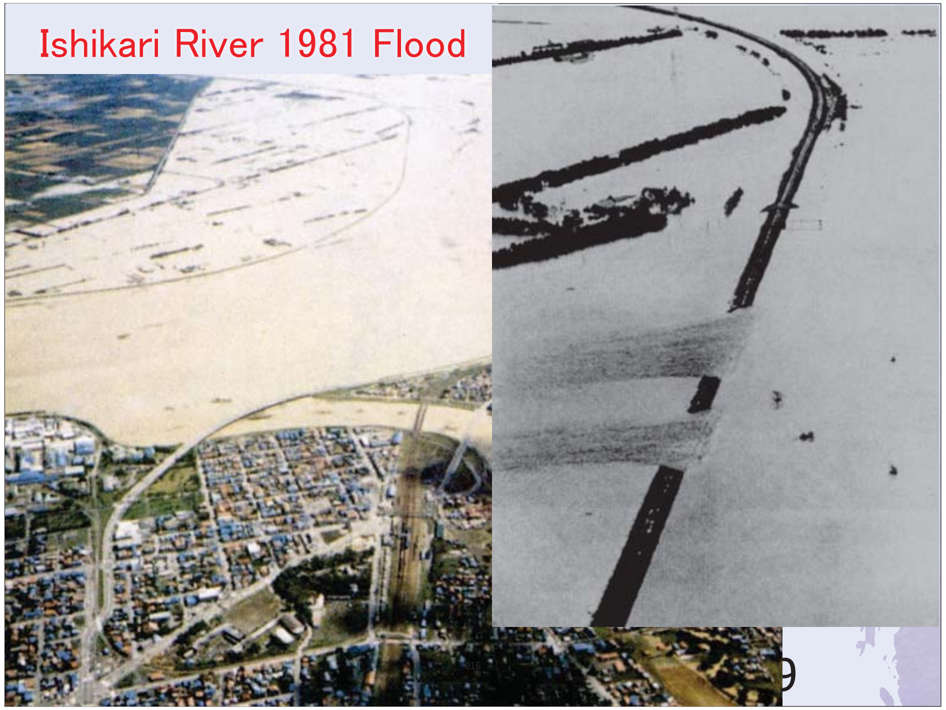
Characteristic features

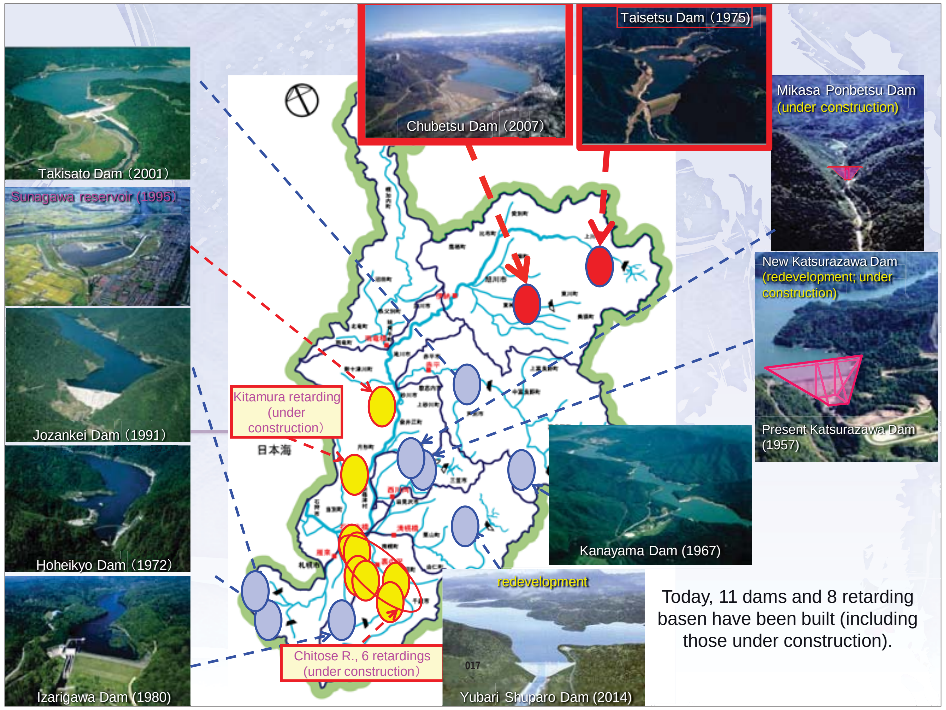
- Population in the Ishikari River Basin: More than 3 million

- More than half the population of Hokkaido live here.

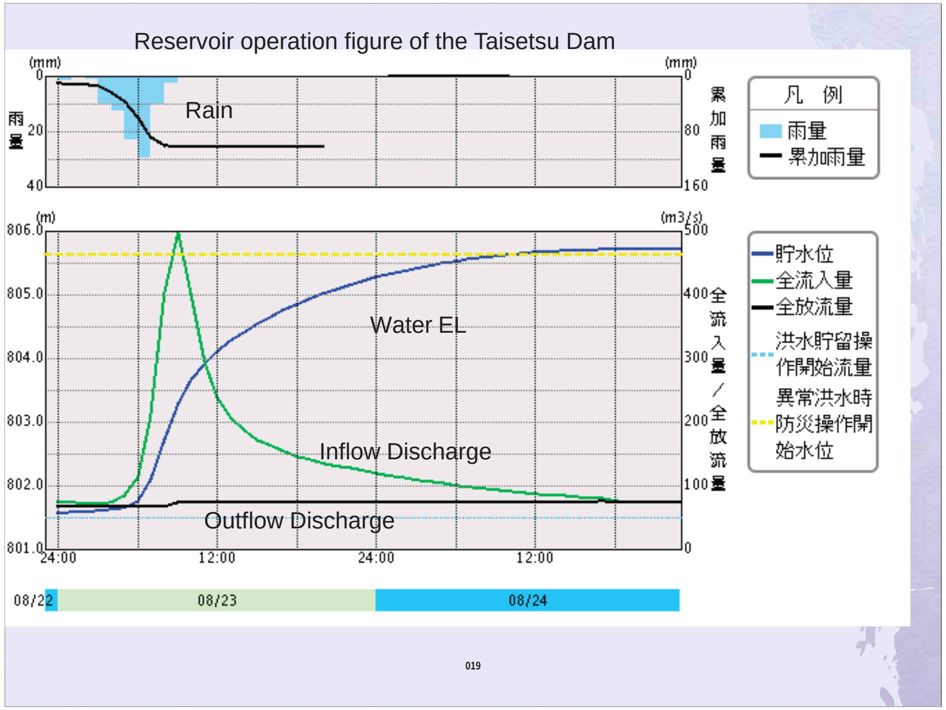


015

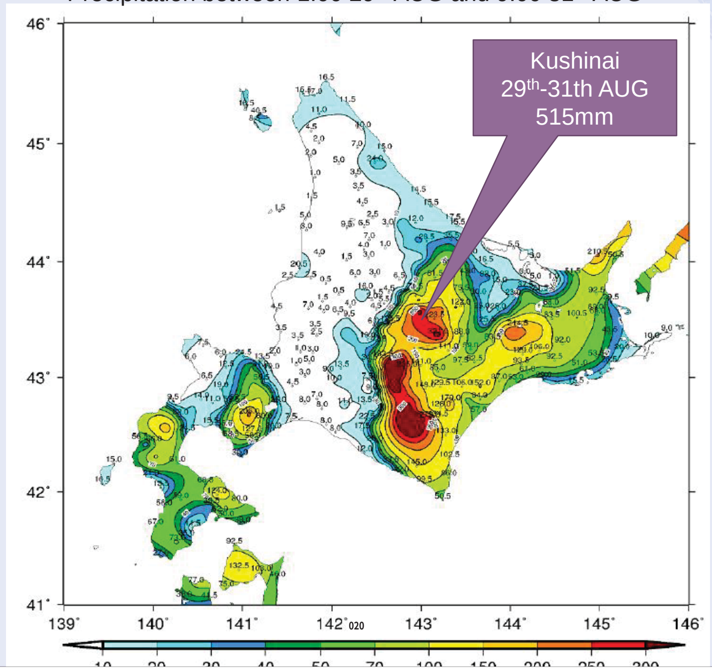

Ishikari River 1981 Flood


Chubetsu Dam (2007)
Taisetsu Dam (1975)
Mikasa Ponbetsu Dam (under construction)
Takisato Dam (2001)
Sunagawa reservoir (1995)
New Katsurazawa Dam (redevelopment; under construction)
Present Katsurazawa Dam (1957)
Jozankei Dam (1991)
Kitamura retarding (under construction)
日本海
Kanayama Dam (1967)
Hoheikyo Dam (1972)
redevelopment
Today, 11 dams and 8 retarding basen have been built (including those under construction).
Chitose R., 6 retardings (under construction)
Izarigawa Dam (1980)
Yubari Shuparo Dam (2014)


Taisetsu Dam
24th AUG 2016


Reservoir operation figure of the Taisetsu Dam
(mm)
雨量
Rain
累加雨量
凡 例
雨量
累加雨量
(m)
(m3/s)
Water EL
Inflow Discharge
Outflow Discharge
全流入量／全放流量
貯水位
全流入量
全放流量
洪水貯留操作開始流量
異常洪水時防災操作開始水位
24:00
12:00
08/22
08/23
08/24

Precipitation between 1:00 29th AUG and 9:00 31th AUG



020

021

022

Inundation of the Sorachi River

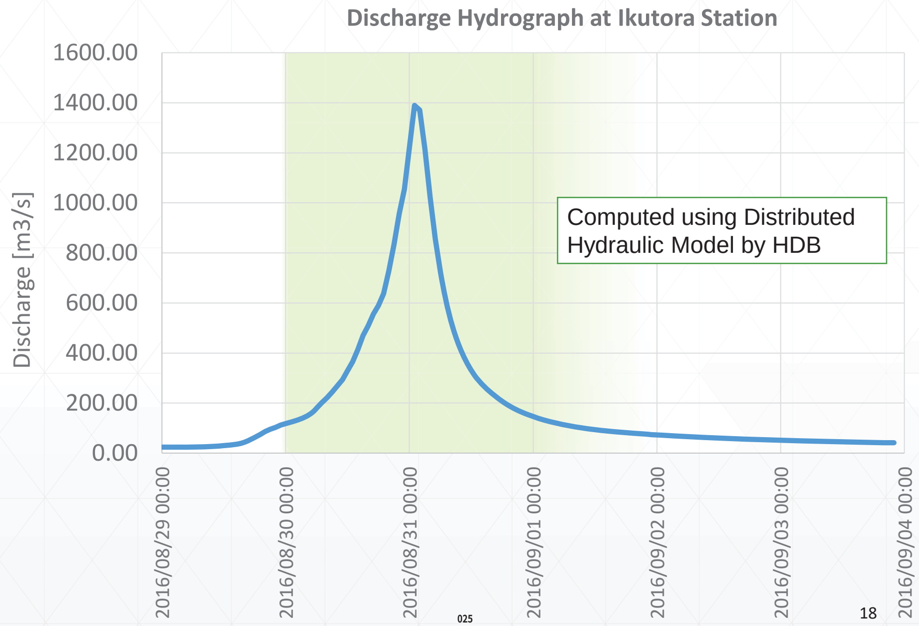
8月31日　6:30　撮影

023

Upstream levee breach point

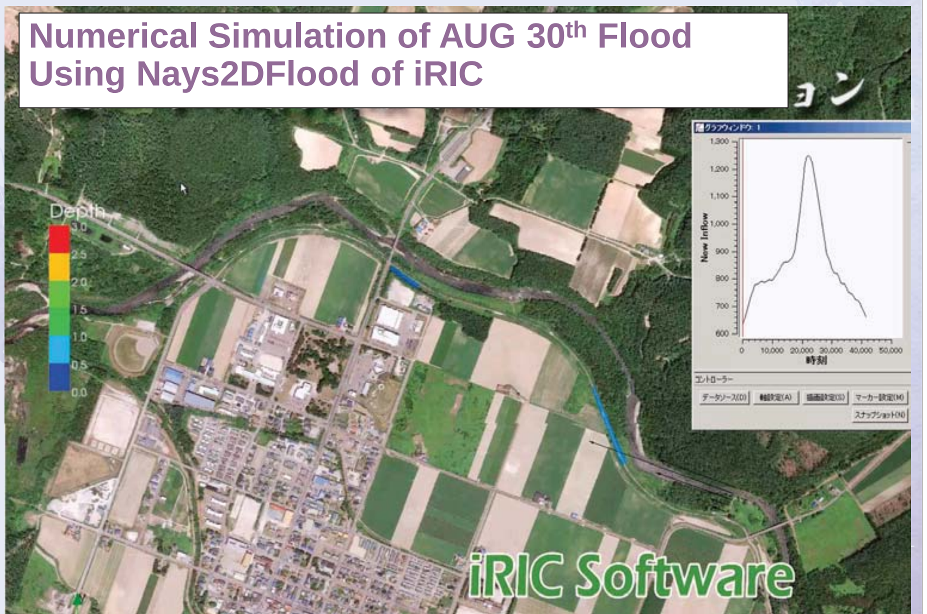
上流側破堤の決壊口上流の写真
撮影：北海道豪雨災害調査団　撮影日：9/1

024　17



025　18

Numerical Simulation of AUG 30th Flood Using Nays2DFlood of iRIC



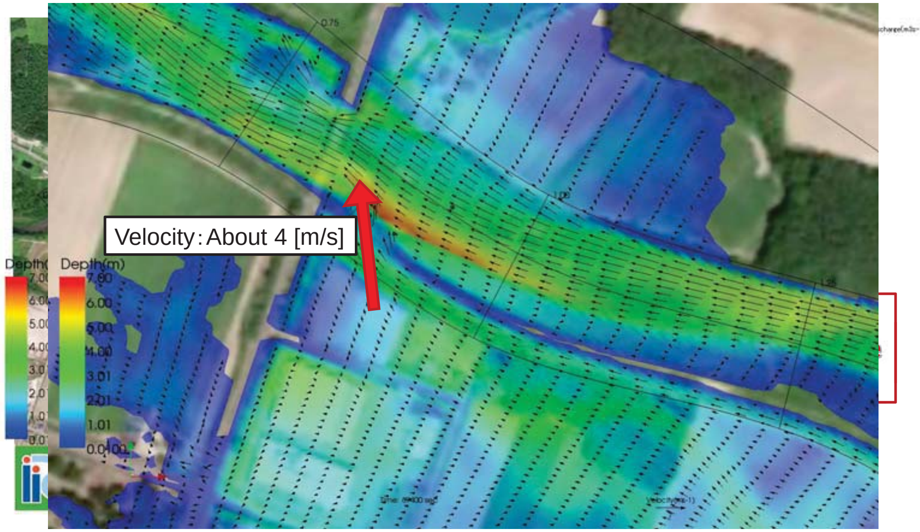
Computation by Y. Yoshida

026

iRIC Software
Changing River Science

計算　石田さん　　HTBイチオシスペシャル(2016年10月1日放送)

027



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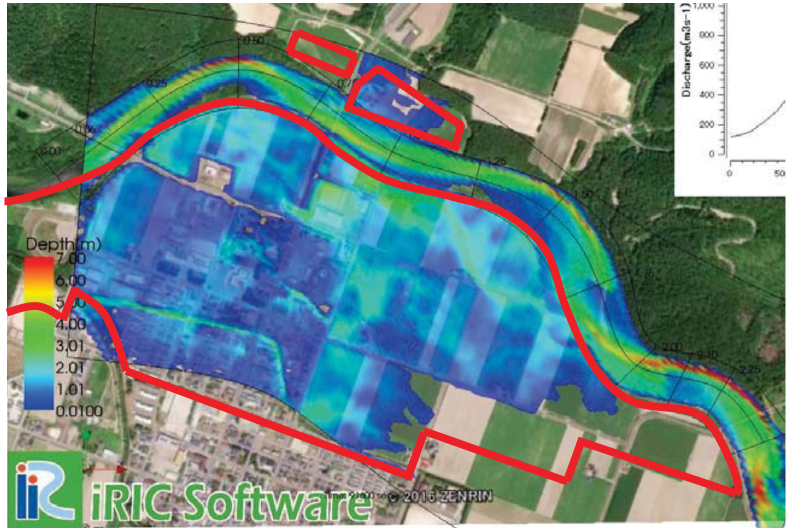
21



029

22

iRIC Software
Changing River Science

Real Scale Levee Breach Experiments by HDB and CERI, 2010

CERI COLD REGION
Incorporated Administrative Agency Public Works Research Institute
Civil Engineering Research Institute for Cold Region

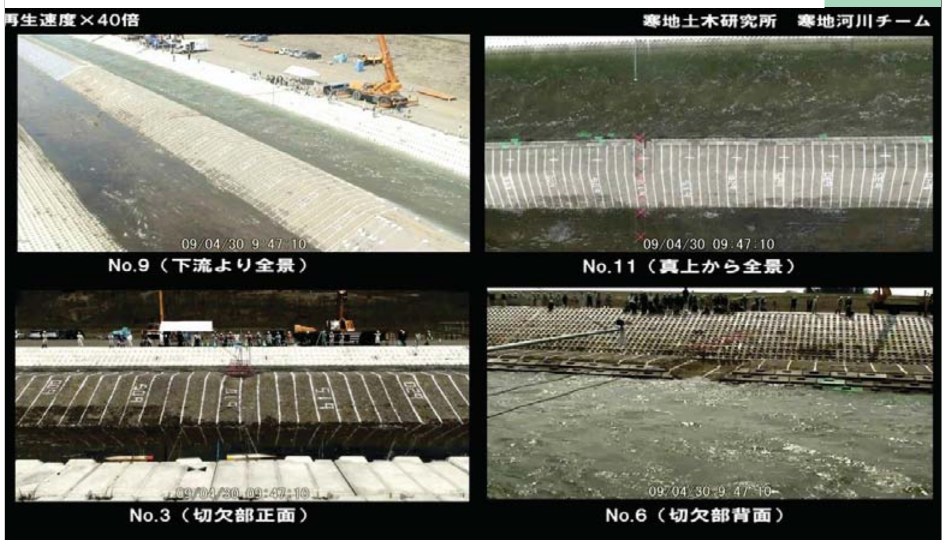
Tokachi River, Chiyoda Flood Way

030

23

CERI COLD REGION
Incorporated Administrative Agency Public Works Research Institute
Civil Engineering Research Institute for Cold Region

iRIC Software
Changing River Science



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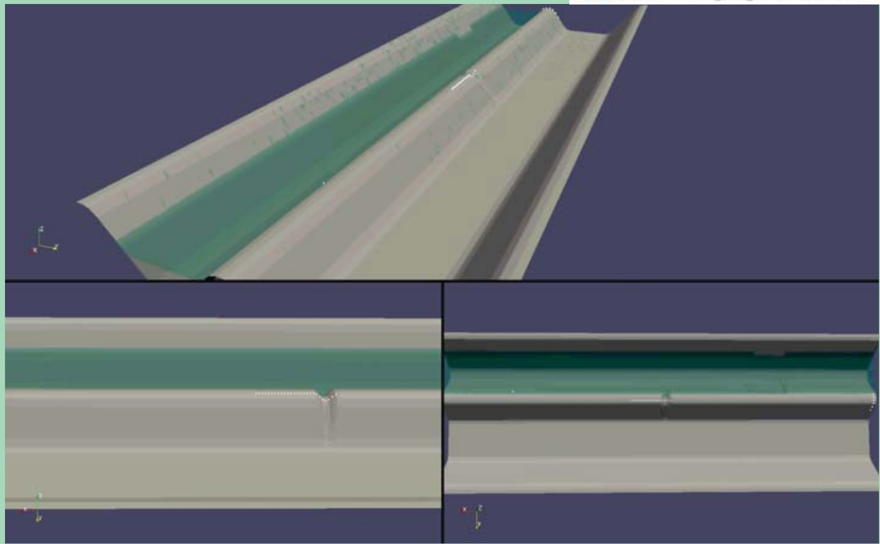
24



iRIC Software
Changing River Science

(Zenno, 2011)

Precipitation between 1:00 29th AUG and 9:00 31th AUG

Dendritic River

Rank	River	Main Prefecture	Catchment area (km^2)
1	Tone	Chiba etc.	16,840
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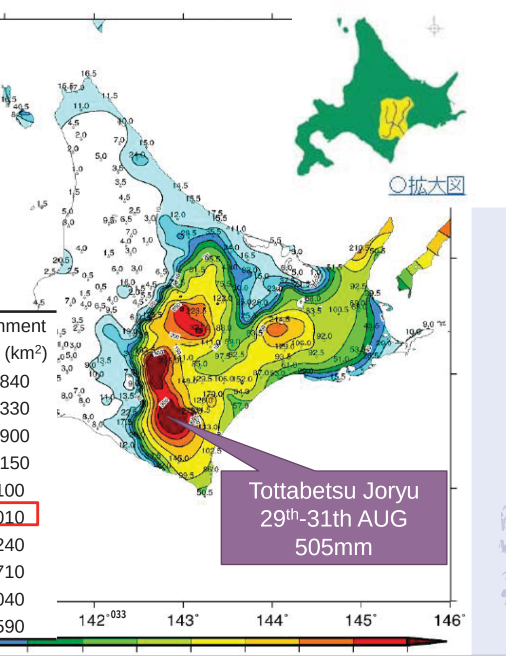
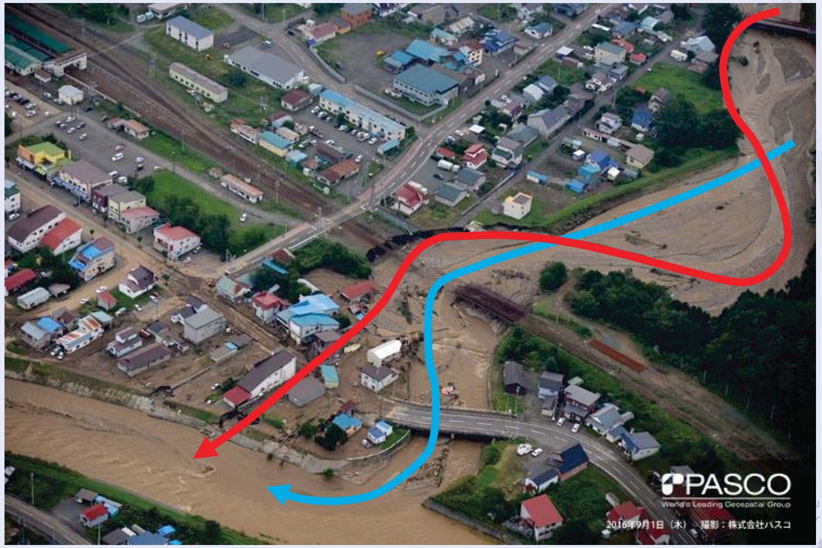




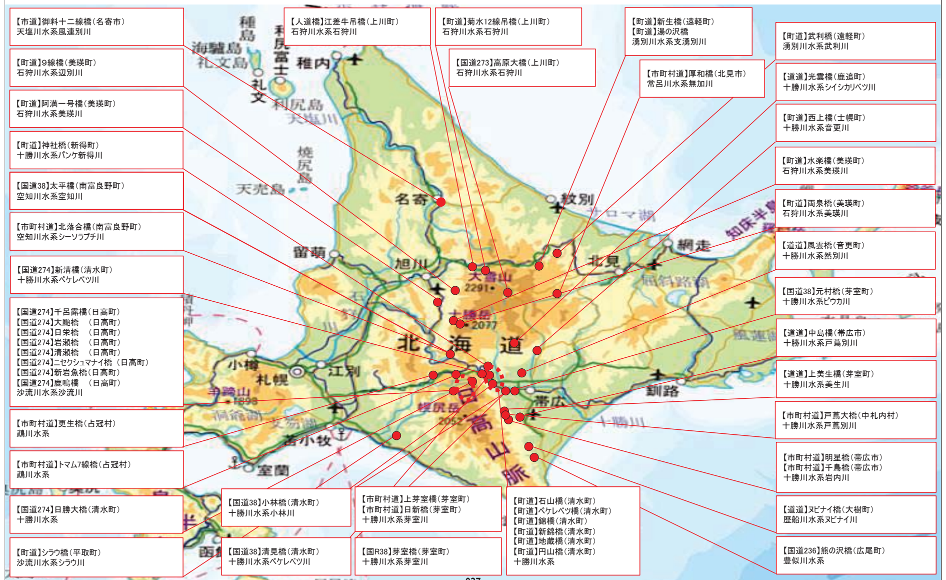
Shintoku Town, the Pankeshintoku River

Shimizu Town, Pekerebetsu River

036

More than 100 Bridges had been damaged.

国土交通省



037

※本資料は速報値であるため、今後の調査で変わる可能性があります。

国土交通省

国道274号 日高町千呂露橋（H28.8.31の状況）

北海道開発局提供

038

国土交通省

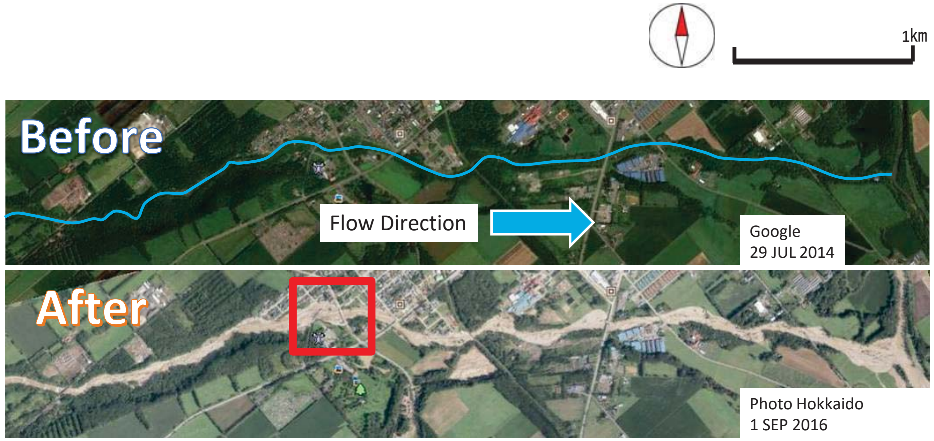
NHK北海道スペシャル(2016年9月30日放送)

国土交通省

040

Pekerebetsu River

国土交通省

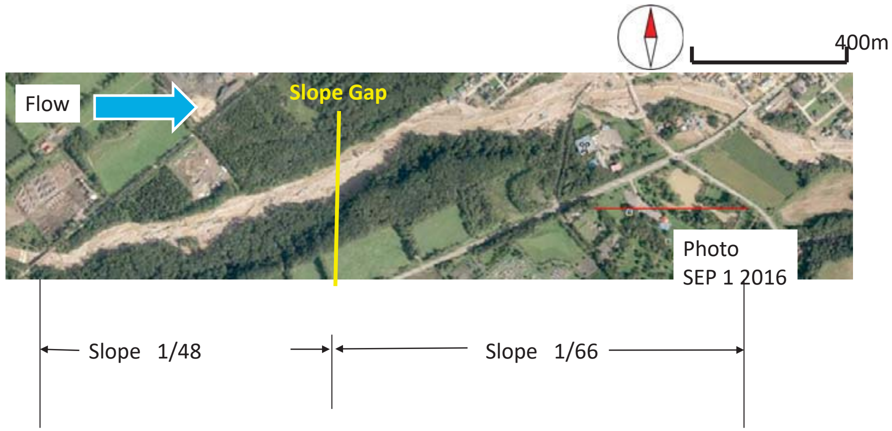


041

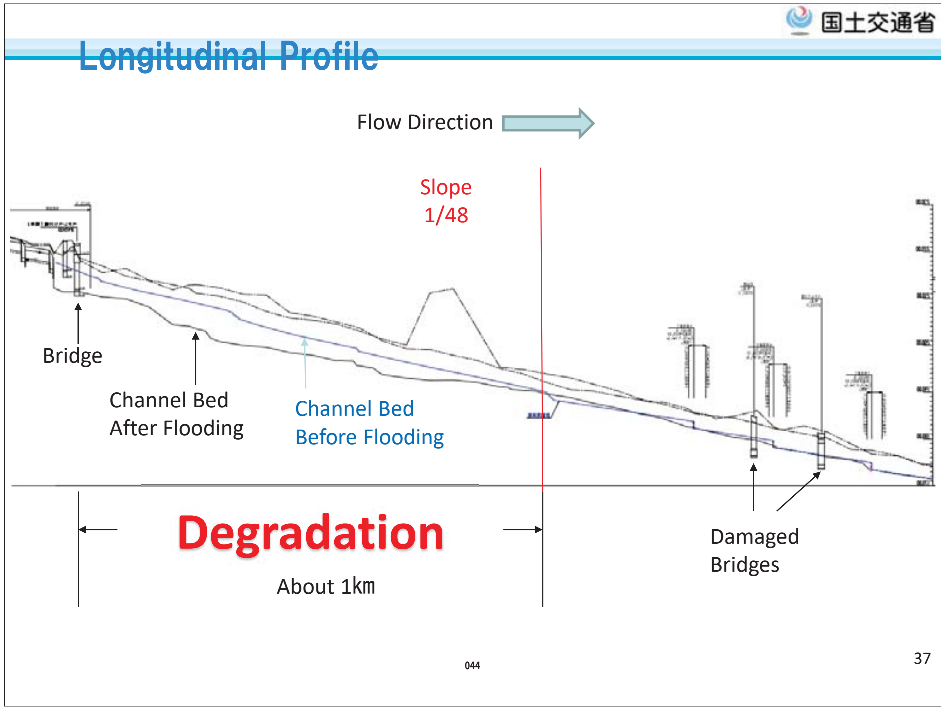
国土交通省

042

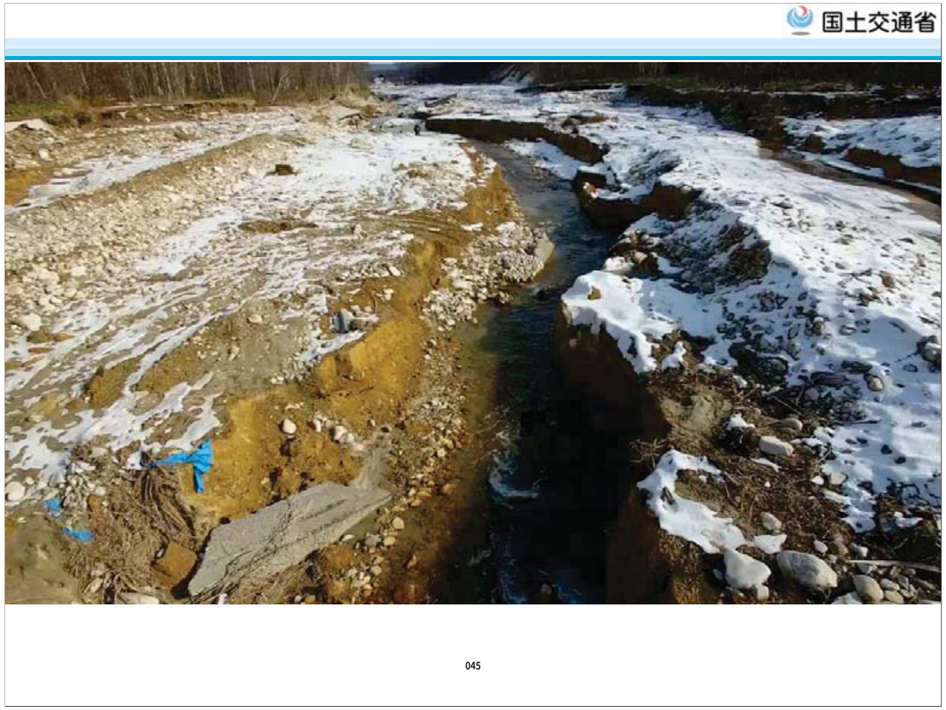
国土交通省



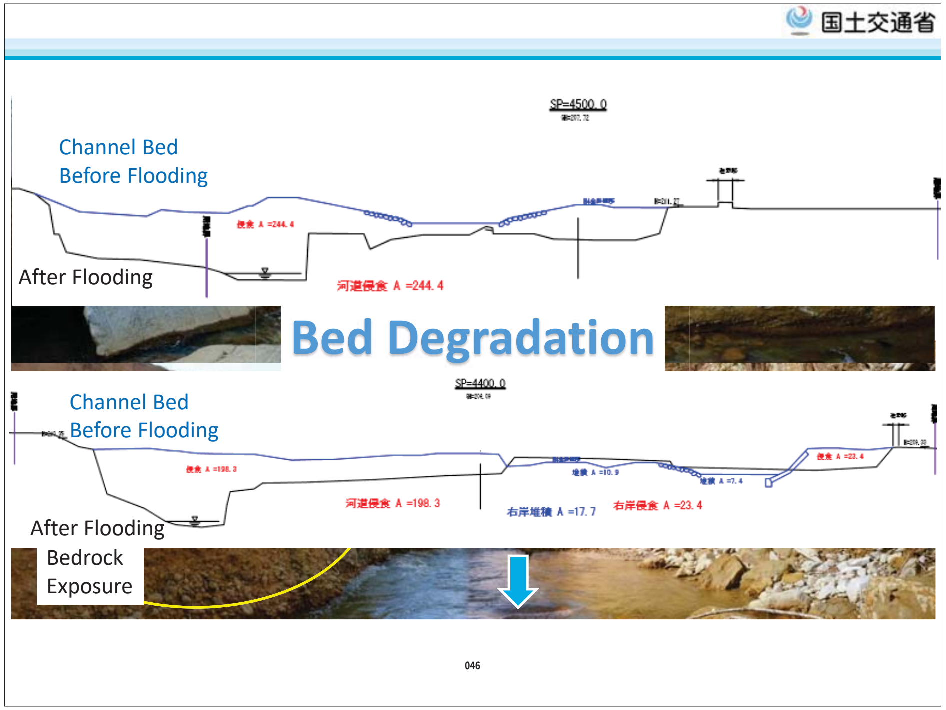
043



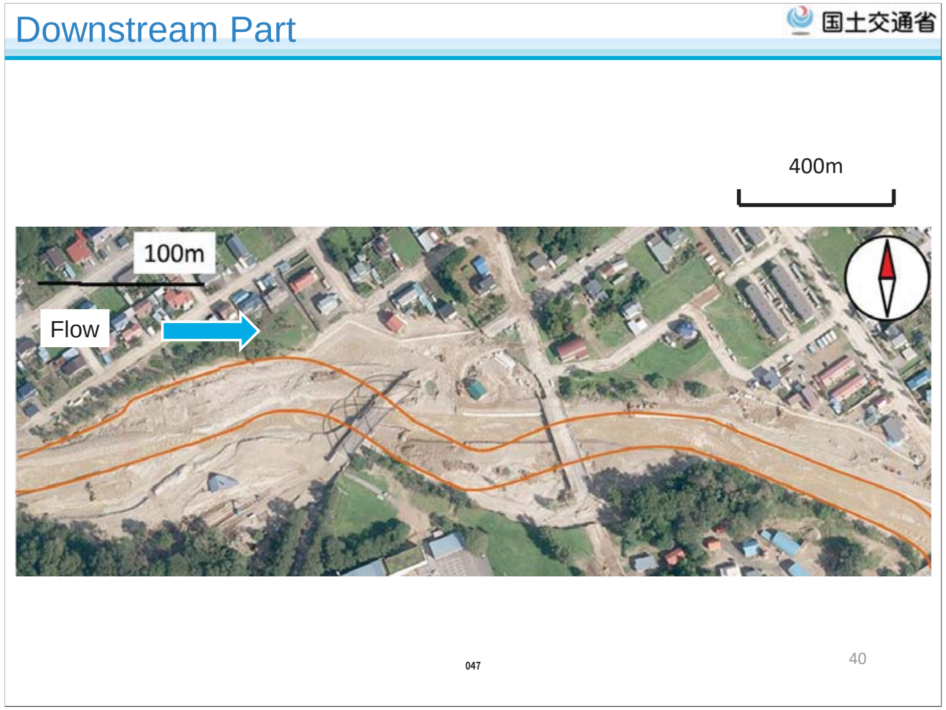
国土交通省
Longitudinal Profile
Flow Direction
Slope
1/48
Bridge
Channel Bed
After Flooding
Channel Bed
Before Flooding
Degradation
About 1km
Damaged
Bridges
044
37



国土交通省
045



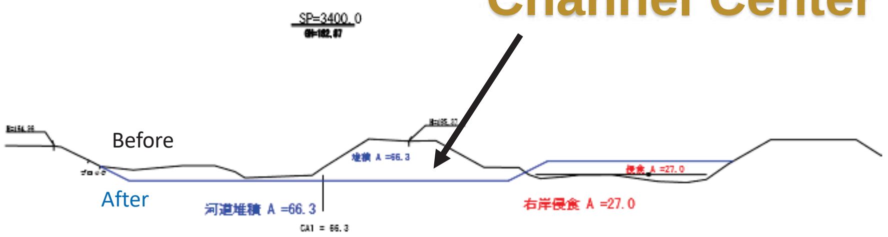
国土交通省
SP=4500.0
Channel Bed
Before Flooding
After Flooding
侵食 A =244.4
河道侵食 A =244.4
Bed Degradation
SP=4400.0
Channel Bed
Before Flooding
侵食 A =198.3
河道侵食 A =198.3
右岸堆積 A =17.7
右岸侵食 A =23.4
After Flooding
Bedrock
Exposure
046



Downstream Part
国土交通省
400m
100m
Flow
047
40

国土交通省

Deposition at Channel Center

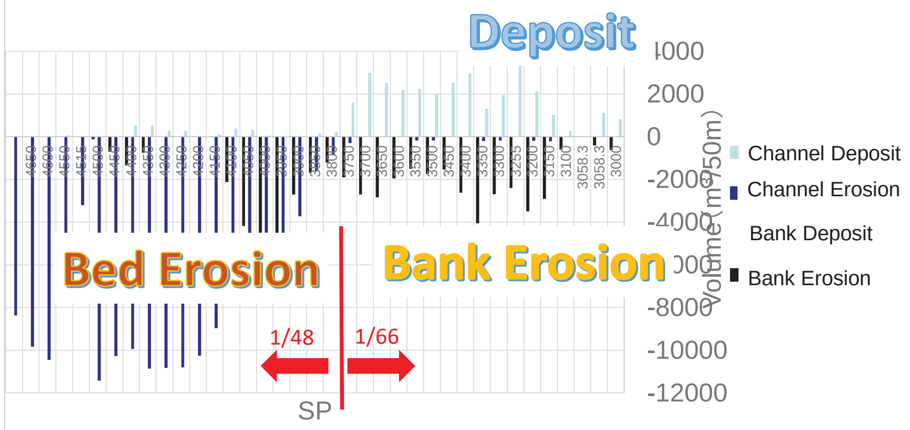


048

41

国土交通省

Sediment Budget (Erosion/Deposition) (m^3)

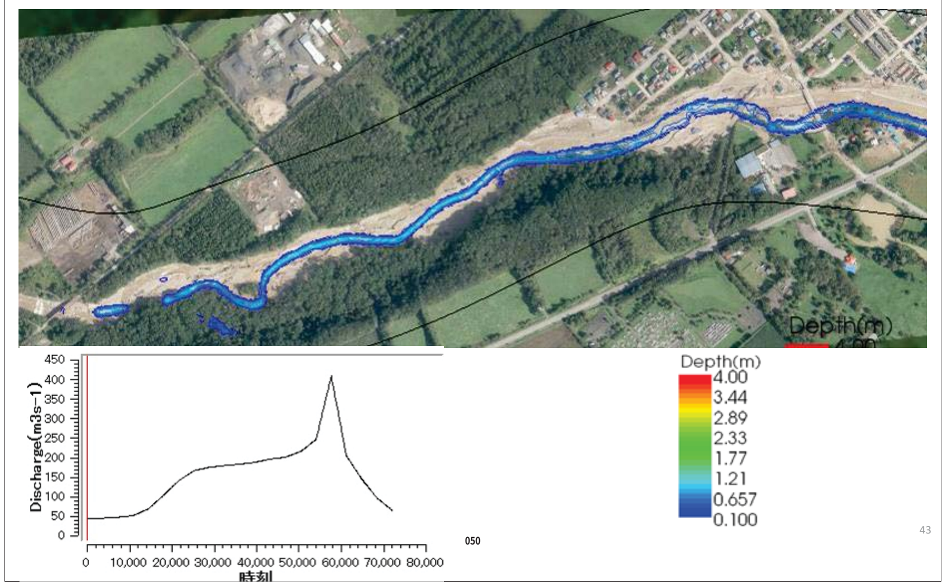


049

42

国土交通省

Computation "without" sediment transport and bed deformation

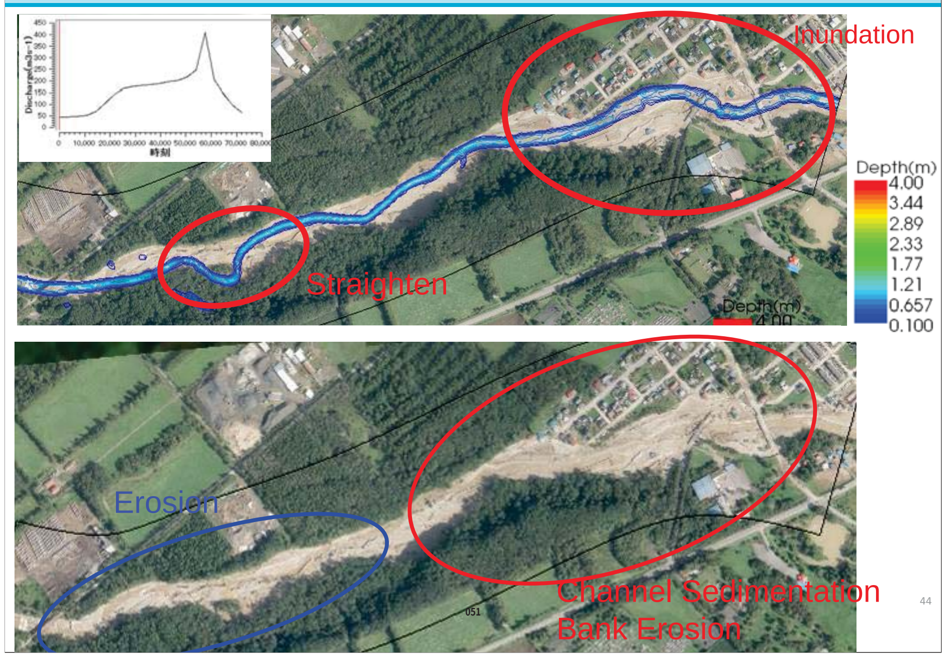


050

43

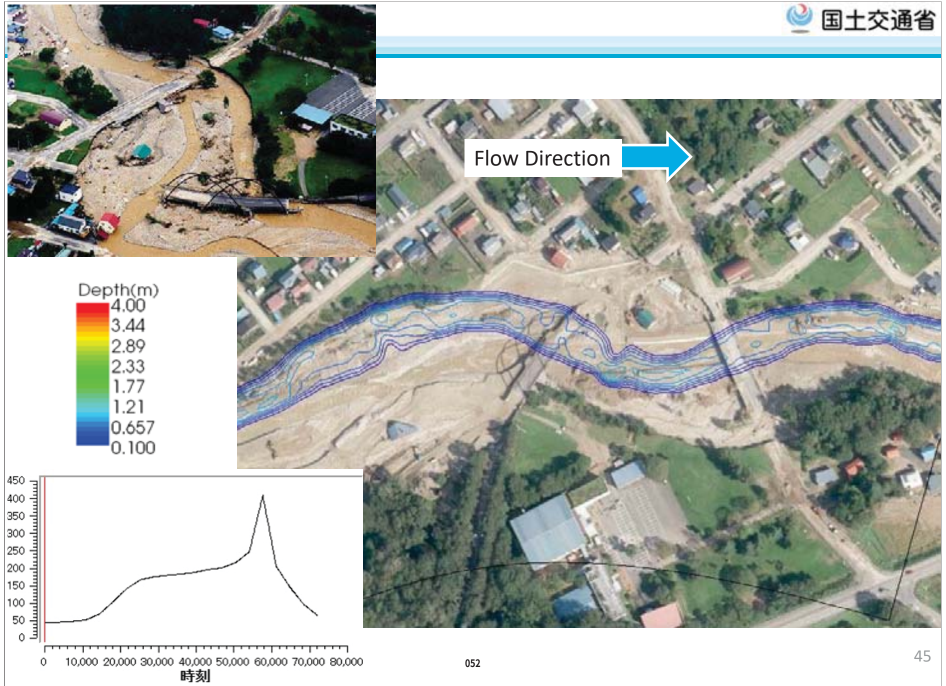
国土交通省

Computation "with" sediment transport and bed deformation



051

44



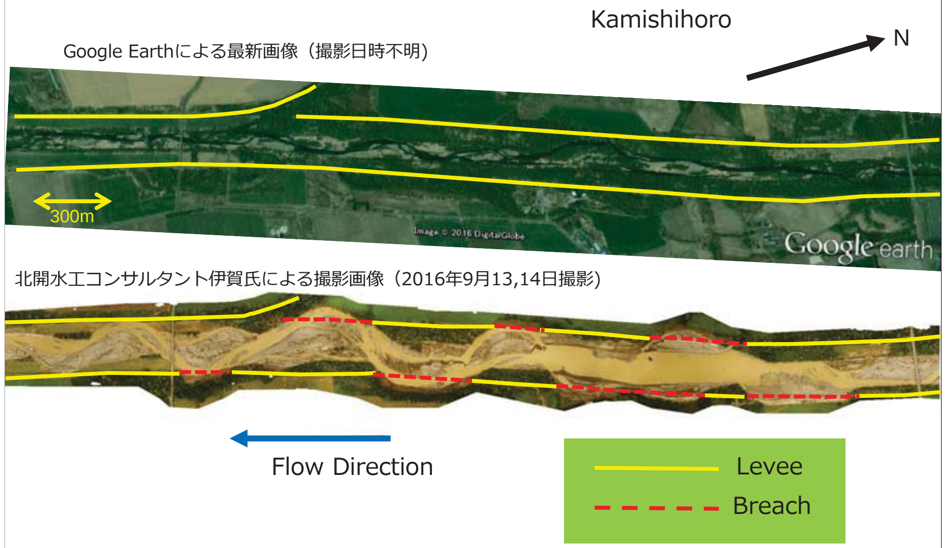
052

Menuro River, 2016

053

Otofuke River
at Kamishihoro Town

Levee Breach in the Otofuke River



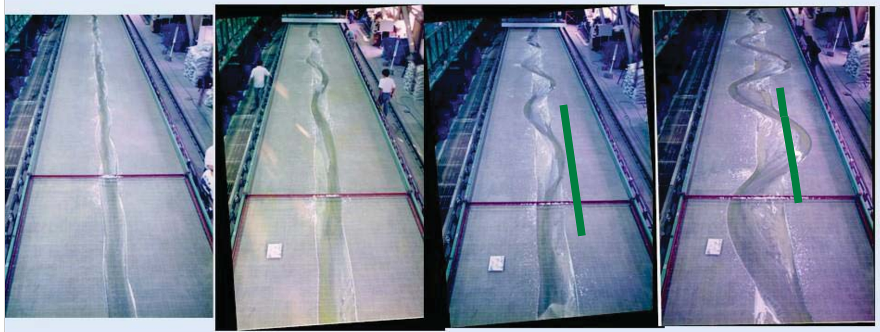
055

After 2011 Flood

After 2016 Flood

056

Time

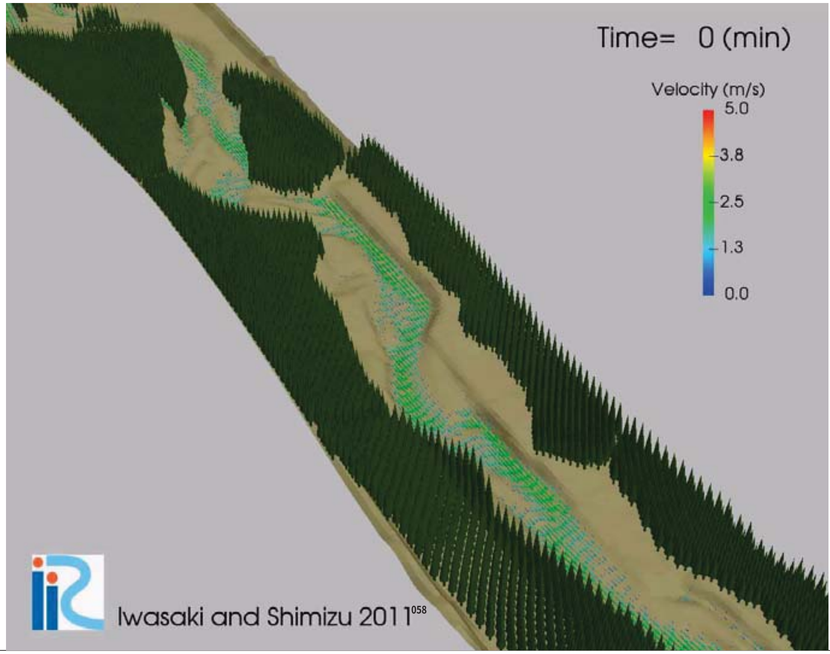


120分 550分 680分 912分

Straight → Slightly Meander → Strongly Meander

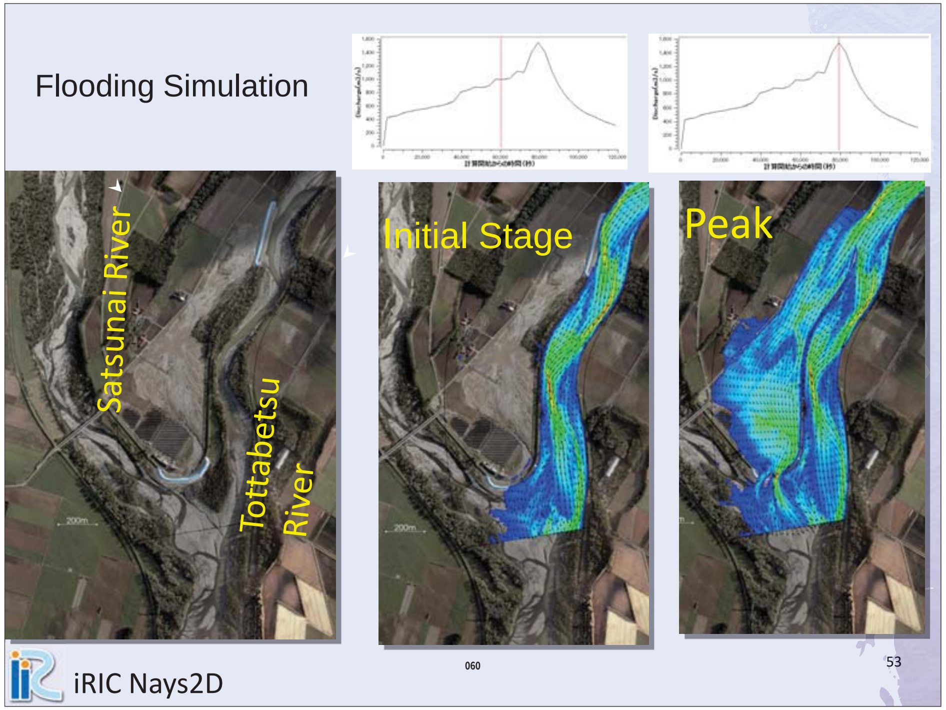
057

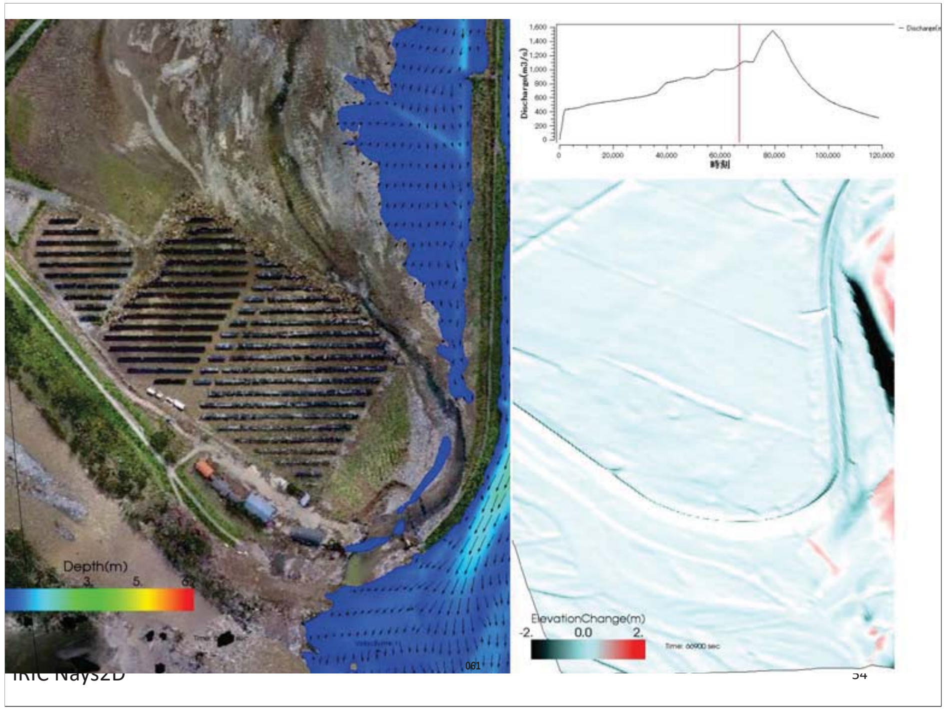
Flow, bed and bank evolution by Nays2D



058

Obihiro, Tottabetsu and Satsunai River





What we found from last year's Flood in Hokkaido ?

- We have experienced unexpected rainfall during August of this year because of 4 typhoons continuously arrived Hokkaido.
- Flood control functions were very effective in all the multi purpose dams in Hokkaido.
- However, rivers upstream of these dams, and rivers without dams are heavily damaged.
- We need more detailed studies, and renewal of flood control planning maybe needed.

062

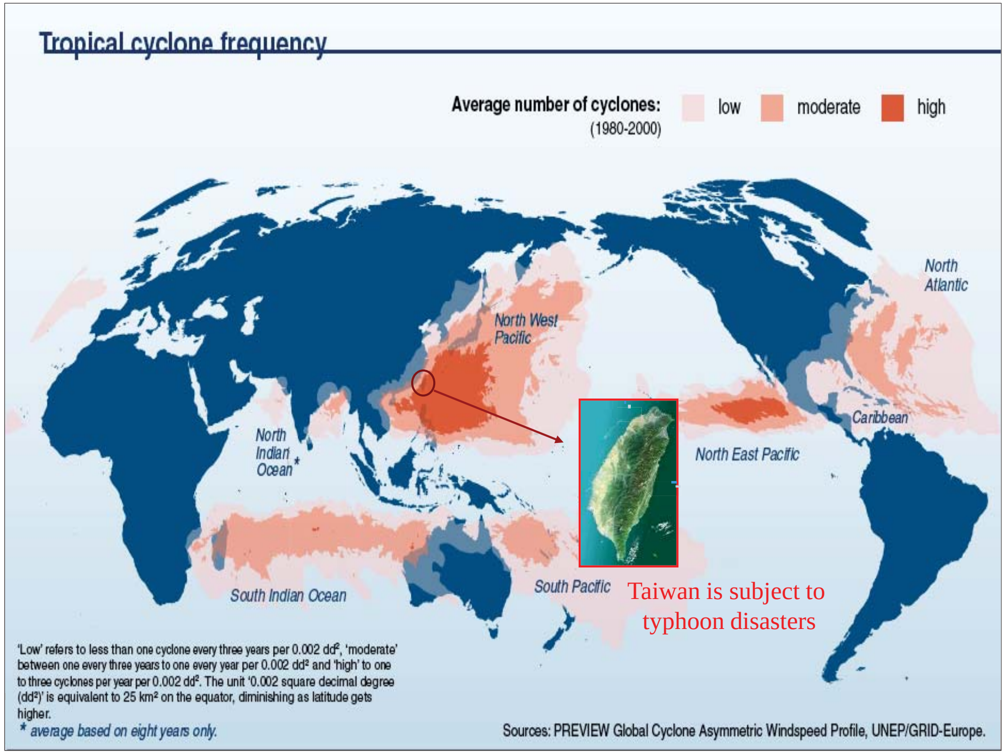
Hazard mapping and Disaster Management of large scale landslides in Taiwan

Dr. Lai, Wen-Chi

Researcher, Disaster Prevention Research Center, Tainan, Taiwan

Outline

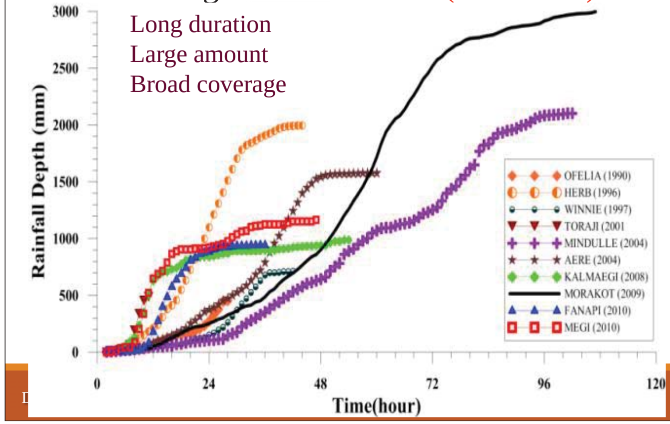
I. Challenges of Typhoon Morakot

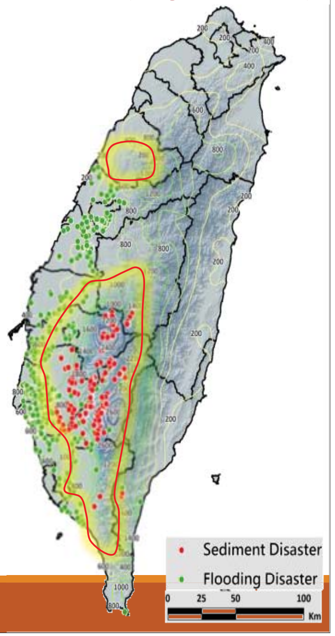


Challenges of Typhoon Morakot, 2009

(Aug 6-10, 2009)

- Max. accumulated rainfall: 3059.5mm.
- Coverage area of total rainfall ≧2000mm: 320,000km^2.
- Total new landslides: 39,492 ha.
- Casualty and missing: 699 people.
- Total damage: 6.7 billion USD(1.6% GDP)





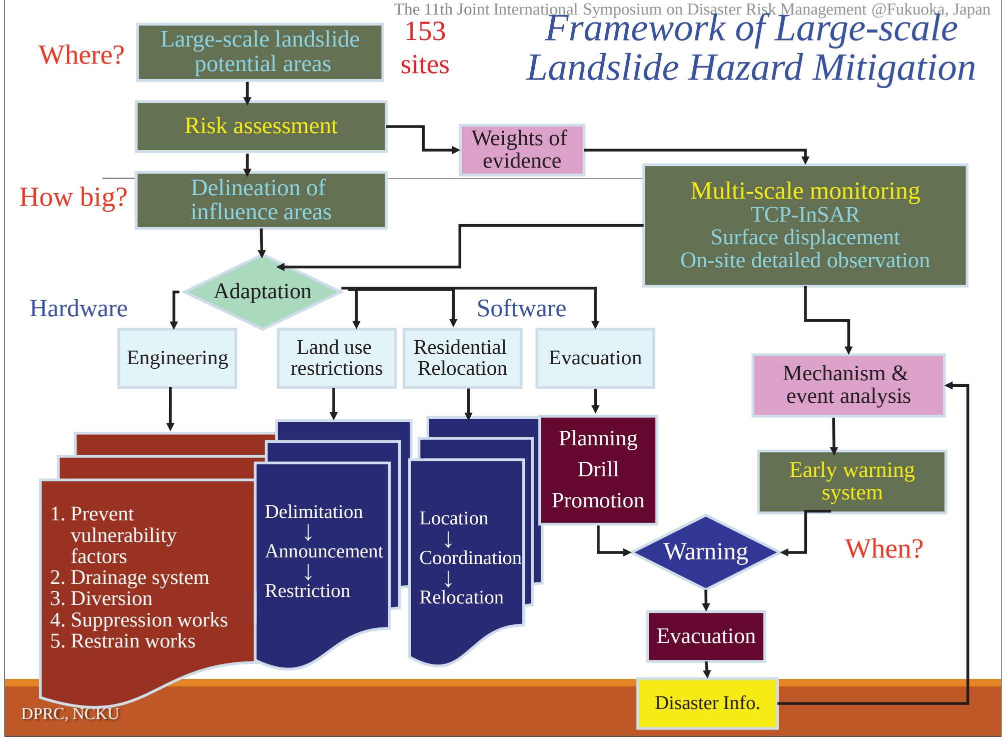
II. Comprehensive Plan of Large-scale Landslide Hazard Mitigation

Comprehensive Plan of Large-scale Landslide Hazard Mitigation under Climate Change Impact

(2017-2020, Budget: 110 million USD)

Definition: Area 10 ha, Depth 10 meters ; Volume 100,000 m^3

Framework of Large-scale Landslide Hazard Mitigation

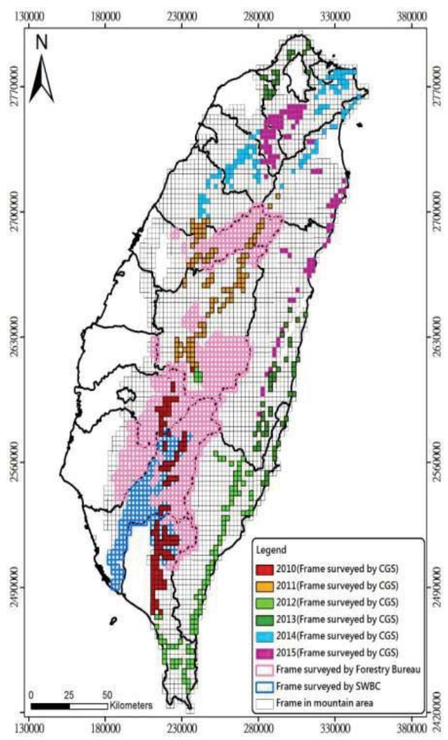


Identification of Large-scale Landslide Potential Areas

- 153 large-scale landslides are selected from 3,763 sites surveyed by CGS, Forestry Bureau, and SWBC.

(2010~2015)

Large Scale Landslide	Central Geological Survey	Forestry Bureau	SWCB	SUM
Analysis Frame	571	763	251	1,482
Sites	1,125	2,523	125	3,763
Potential areas (km^2)	413.86	789.30	49.62	1,178.01



Risk Assessment of 153 Large-scale Potential Landslide

Risk = Hazard X Vulnerability

Risk degree = Occurrence degree X Protected targets

Occurrence Degree *(Weights of evidence)*

- 8 Factors: Aspect, Slope, Vegetation(NDVI), Rock mass strength, Dip slope degree, Elevation, Distance of river, Distance of geological structure

Protected Targets

- **Buildings**
- **Transportation facilities**
- Important infrastructures
- Water storage range of reservoir

Risk Degree (153 sites)		***Occurrence degree***		
		Low	***Mid***	***High***
Protected Targets	***Low***	*Low*	*Low*	*Mid*
	Mid	*Low*	*Mid*	*High*
	High	*Mid*	*High*	*High*

Multi-scale Monitoring of Large-scale Potential Landslide Areas

Risk Degree

Risk	Observation	Methods
High Risk	On-site Detailed Observation	Geophysical exploration; Geological survey; Geological boring; Ground water; Surface and Underground displacement
Middle Risk	Surface Displacement Observation	Single frequency GPS; Extensometer; Rain gauge
Low Risk	Long-term Observation	TCP-InSAR Techniques Extensive Observation

III. Risk Assessment of Large Scale Landslide

Definition of risk assessment of large scale landslide

Risk = Hazard × Exposure × Vulnerability

Hazard：Deposition Depth、Veolocity、Energy …etc.

韋等(2003)、胡等(2003)、Jakob and Hungr(2005)、Lateltin et al.(2005)、Jaboyedoff et al.(2005)唐與朱(2006)、陳等(2007)、曹等(2010)、Peng et al.(2015)、羅等(2016)

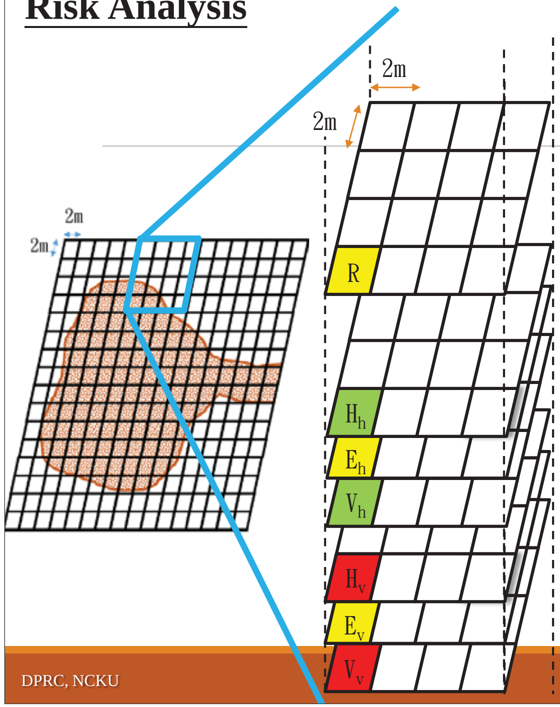
Exposure：Spatial distribution / Temporal duration of protection object.

Bell and Glade(2004)、陳等(2006)、唐與朱(2006)、鐵等(2010)、曹等(2010)

Vulnerability：The Loss curve of damaged building, land or other properties.

曹等(2010)、Lo et al.(2012)

Risk Analysis



Debris Flow

Grid-Mesh in 2m×2m

Hazard：
(1) Deposition/Ersion Depth
(2) Velocity of Debris-Flow

Exposure

Vulnerability

Risk

$$R=\frac{1}{2}(H_h\times E_h\times V_h)+\frac{1}{2}(H_v\times E_v\times V_v)$$

Hazard Analysis

Base on the numerical simulation of Debris-Flows, checking the impact by the results.

Deposition Depth (m)	H_h	Veolocity (m/s)	H_v
<0.5	0	0~1.5	0
0.5~1	0.2	1.5~2.5	0.2
1~2	0.4	2.5~6	0.4
2~3	0.6	6~8	0.6
3~5	0.8	8~12	0.8
>5	1	>12	1

Deposition Depth

Assuming the risk rise up when deposition depth >0.5m (usually the effective height of the structures)

施等人(1997)、Liu et al.(2009)、水土保持手冊

Velocity

The velocity ≧ 1.5m/s the erosion on the slope rise up， the velocity ≧ 2.5m/s the erosion on the grassland ，the velocity ≧ 6m/s、8m/s、12m/s made the scouring in different structure。

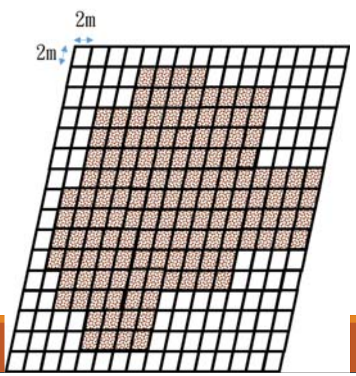
水土保持手冊

Exposure Analysis

Base on the numerical simulation of Debris-Flow, checking the impact from each gridmesh.

Deposition depth、Maximum velocity
Mapping the effected area by the criteria：
(1) Deposition depth ≧ 0.5m → E_h=1
(2) Maximum velocity ≧ 1.5m/s → E_v=1

- Outside of effected area：Exp.=1
- Inside of effected area ：Exp.=0

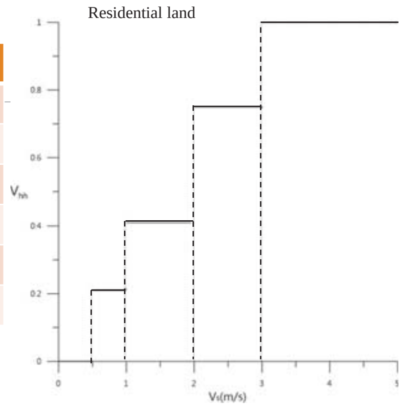


Exp. =1
Exp. =0

Vulnerability Analysis

Loss curve of damaged in deposition depth

ΔZ(m)	V_{hh}	V_{hr}	V_{ha}	V_{hf}
0~0.5	0	0	0	0
0.5~1	0.21	0.15	1	0
1~2	0.41	0.3	1	0
2~3	0.55	0.5	1	0.33
3~5	1	0.8	1	0.66
>5	1	1	1	1



$V_{\alpha\beta}$:Vulnerability in condition of α and β

α ：Deposition depth (h)、velocity (v)

β ：residential land (h)、highway (r)、Agricultural Land (a)、forest (f)

Risk Map

$$R=\frac{1}{2}(H_h\times E_h\times V_h)+\frac{1}{2}(H_v\times E_v\times V_v)$$

$$V_h=(0.4V_{hh}+0.3V_{hr}+0.2V_{ha}+0.1V_{hf})\times I_{DR}$$

$$V_v=(0.4V_{vh}+0.3V_{vr}+0.2V_{va}+0.1V_{vf})\times I_{DR}$$

$H_h=0\sim1$ $E_h=0\sim1$

$H_v=0\sim1$ $E_v=0\sim1$

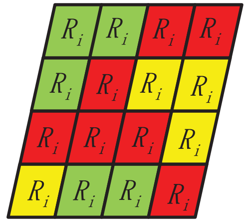
$V_{\alpha\beta}=0\sim1$

Risk classify：divide into three level，

R_{min}：0

R_{max}： $1\times1\times(0.4\times I_{DR})$

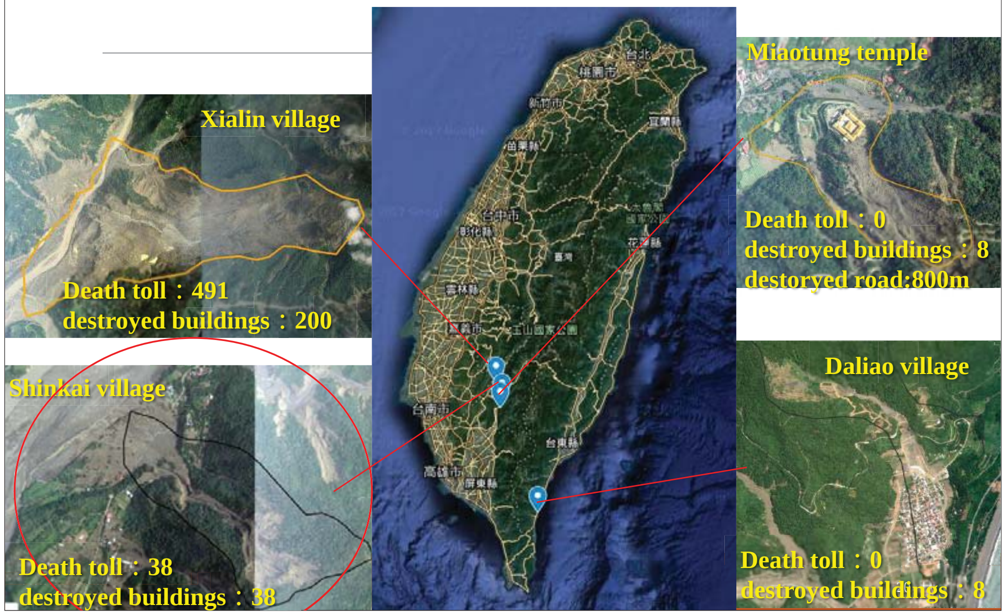
Risk Class	Risk Value
High	$0.26\times I_{DR}$ ~ $0.4\times I_{DR}$
Medium	$0.13\times I_{DR}$ ~ $0.26\times I_{DR}$
Low	0 ~ $0.13\times I_{DR}$



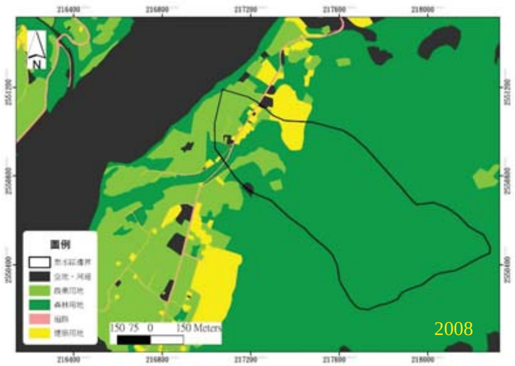
IV. Cases Study

Case study area

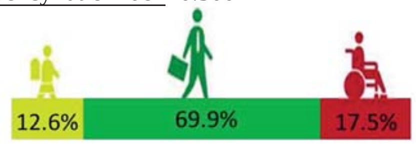
Four debris flow disasters triggered by rainfall during typhoon Morakot in 2009.



Terrain Analysis

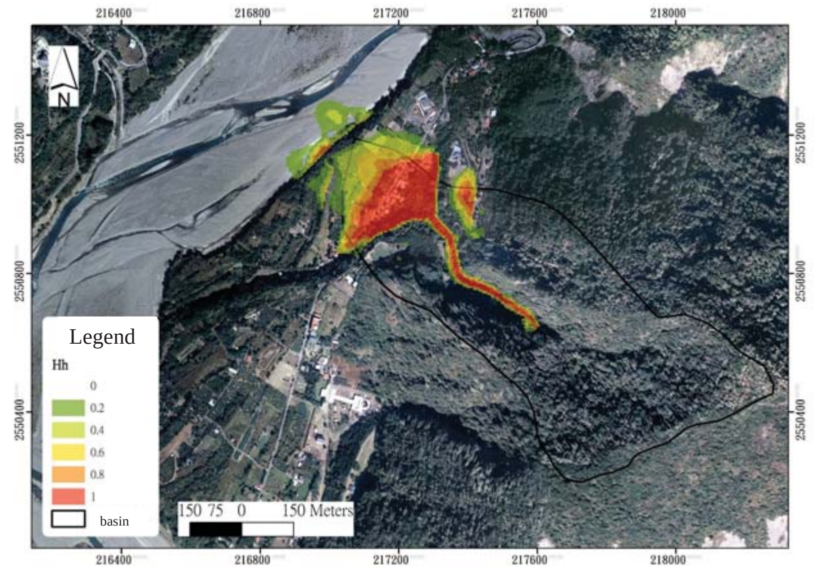


2009/6，Sinkai village
Dependency ratio index=0.3007

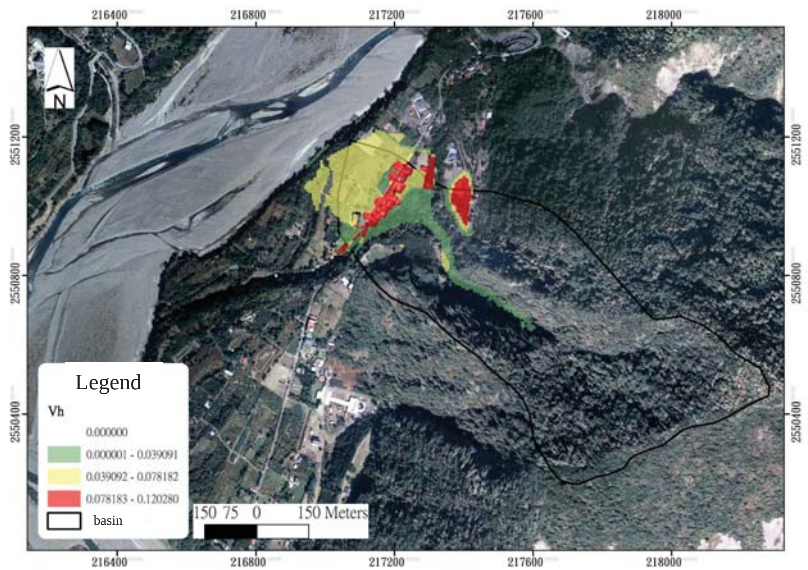


Children Adult Elderly

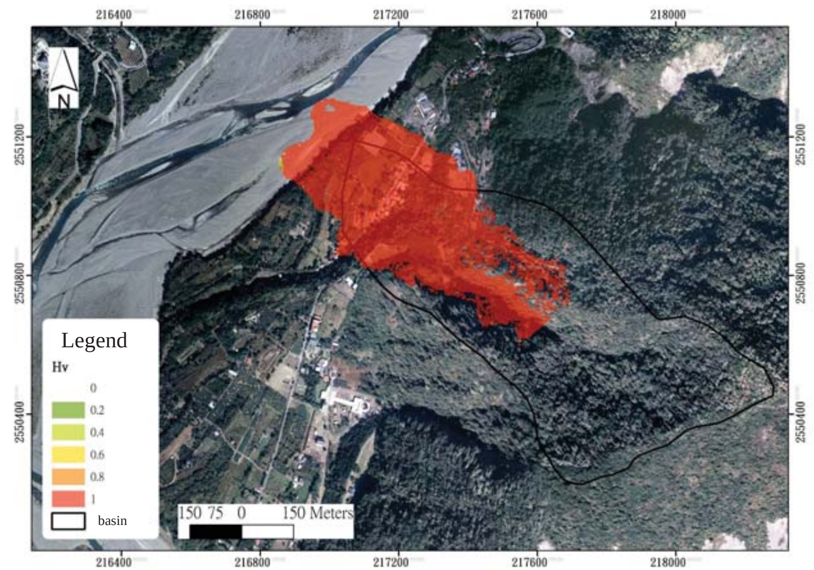
Hazard: Deposition depth (H_h)



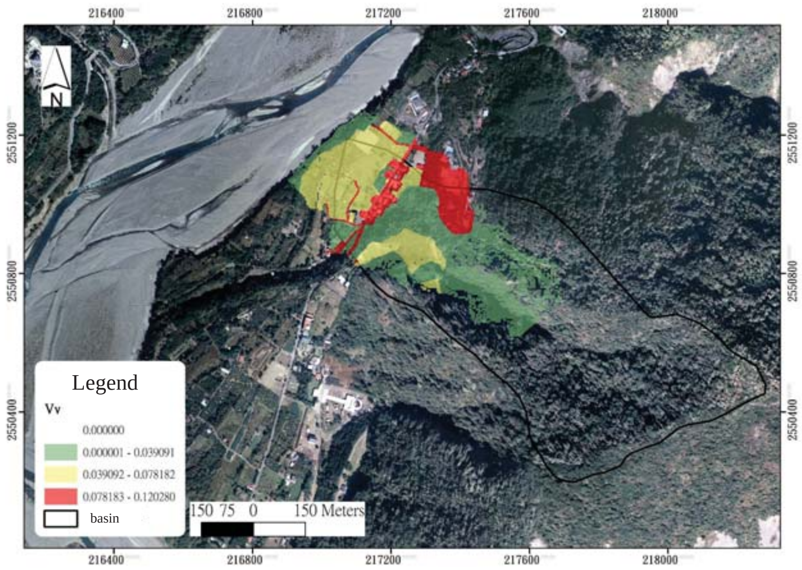
Vulnerability : Deposition depth (V_h)



Hazard : Velocity (H_v)

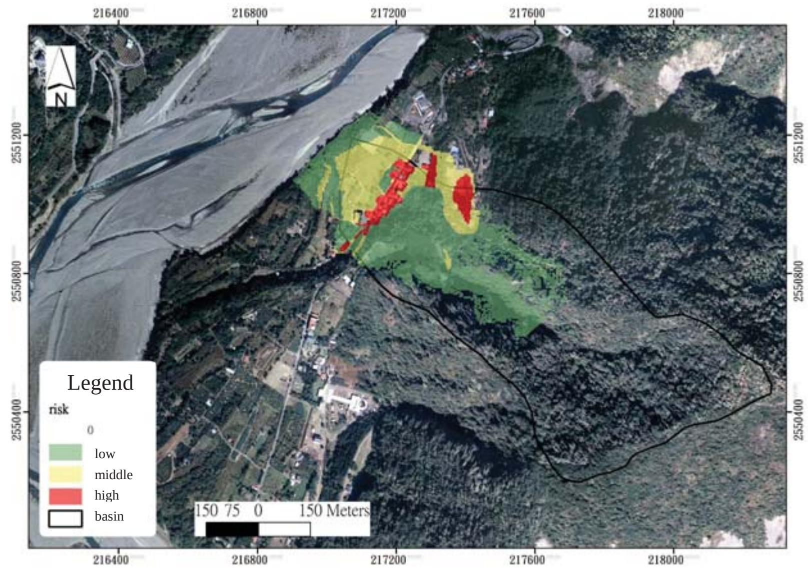


Vulnerability : Velocity (V_v)

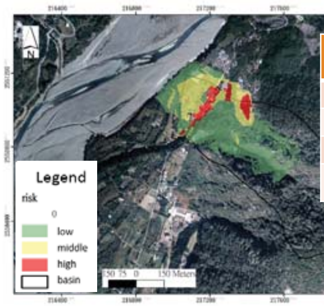


Shinkai Village-Debris flow disaster risk R

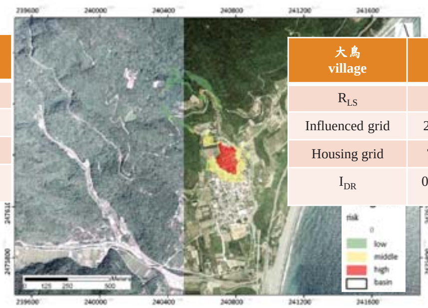
$$R = \frac{1}{2}(H_h \times E_h \times V_h) + \frac{1}{2}(H_v \times E_v \times V_v)$$



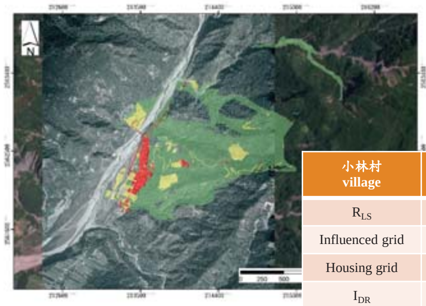
Risk mapping of study areas



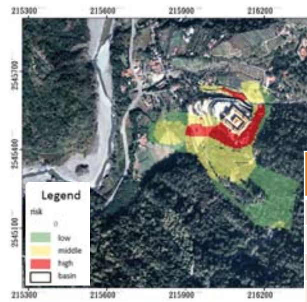
新開 village	
R_{LS}	2368
Influenced grid	85588
Housing grid	7955
I_{DR}	0.3007



大鳥 village	
R_{LS}	781
Influenced grid	29748
Housing grid	7298
I_{DR}	0.2754



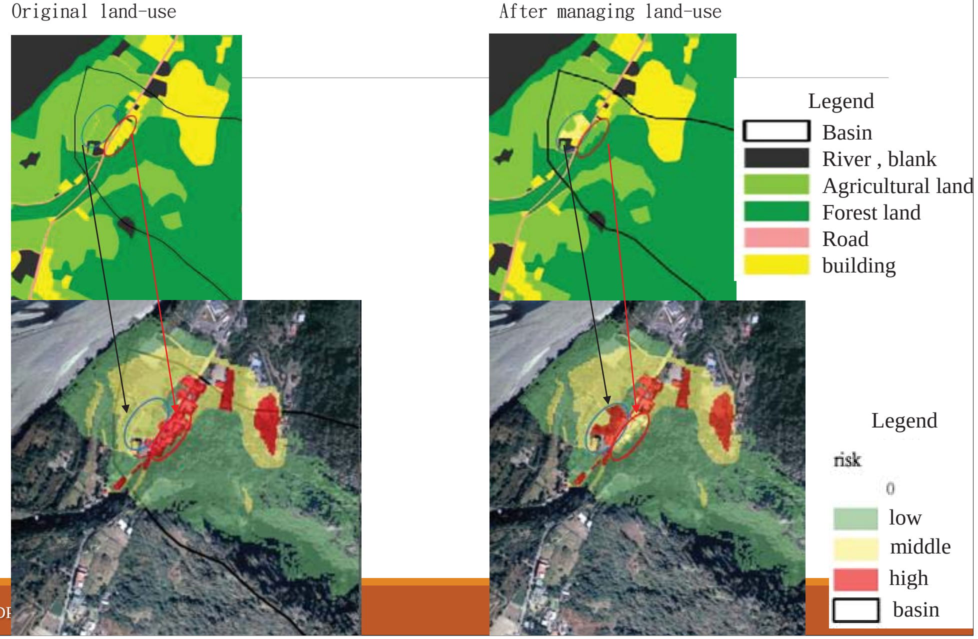
小林村 village	
R_{LS}	13478
Influenced grid	525085
Housing grid	19761
I_{DR}	0.2908



妙崇 temple	
R_{LS}	1736
Influenced grid	39522
Housing grid	13687
I_{DR}	0.3055

The relationship between debris flow risk and land-use

Land-use have a great effect on the risk distribution in a regional area ➡ Manage the land-use



V. Summary

1. The prevention measures for debris flows disasters have been developed more than 15 years. The experiences could be the basis of developing a new mitigation strategy for large-scale landslide.
2. From the lessons of Hsiaolin village, the large-scale landslide has become a new challenge in the coming future of Taiwan which results in the brand new project-the comprehensive plan of large-scale landslide hazard mitigation under climate change impact. It might take another 10 years to fulfill all those tasks.
3. Different up-to-date techniques such as Lidar DEM, TCP InSAR, single frequency GPS system, traditional on-site detailed observation skills and BATS system should be integrated in order to mitigation the possible hazards of large scale landslides.

SATREPS Project

Wadi Flash Floods Integrated Management Considering Climate Change for Secured Development in Egypt (WaFFIME)

Mohamed Saber, Sameh A. Kantoush, Tetsuya Sumi , Mohammed Abdel-Fattah

Disaster Prevention Research Institute, Kyoto University, Gokasho, Uji 611-0011,Japan

The 11th Joint International Symposium on Disaster Risk Management, 11-13 Sept. 2017, Ito Campus, Kyushu University , Japan

Contents

- Introduction and problem statements
- Recent Flash floods in Egypt
- *SATREPS_Project*
- *Hydrological Approaches and Applications*
- *Conclusions*

Introduction and problem statement

Wadi System in the arid regions?

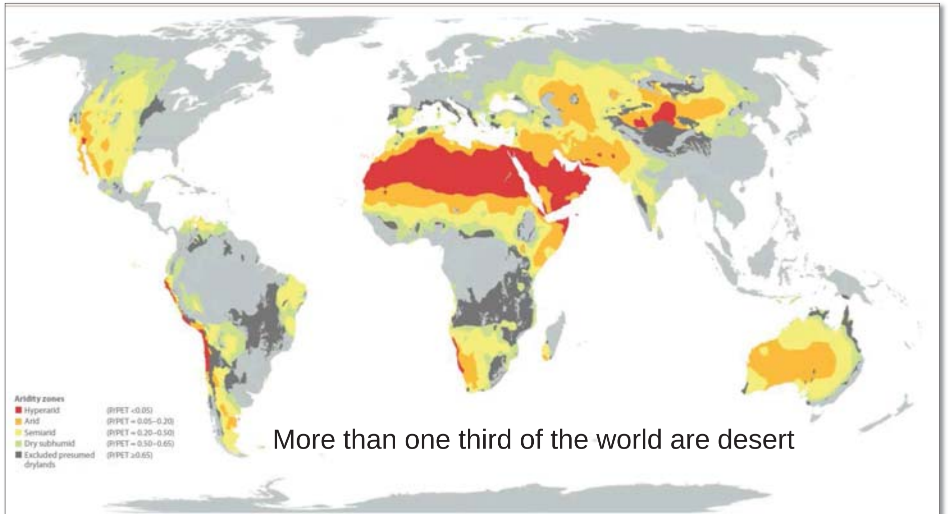
Wadi is an Arabic word for ephemeral streams in the arid regions.

Wadi= Ephemeral stream

Perennial stream

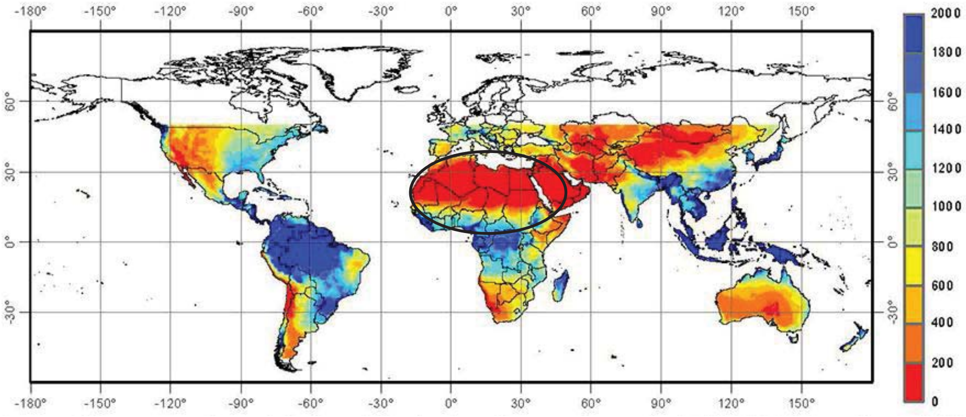
Introduction and problem statement

Wadi System Problems



http://www.fao.org/fileadmin/user_upload/newsroom/docs/full-map.png

Introduction: Water Availability and Scarcity

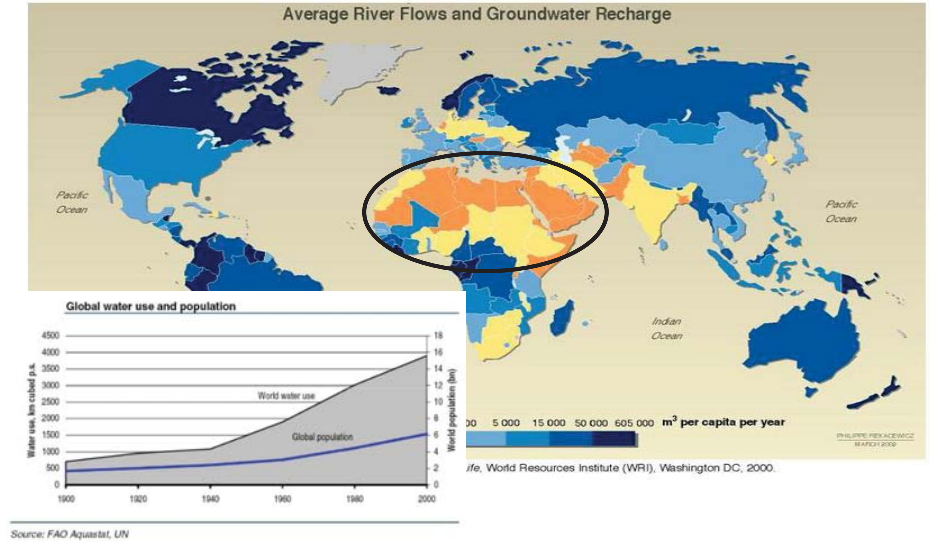


Mean annual precipitation of the land surface for the period 1998-2013 from the TRMM data

http://www.beg.utexas.edu/cswr/BP/index.php

Introduction: Water Availability and Scarcity

Global Water Availability



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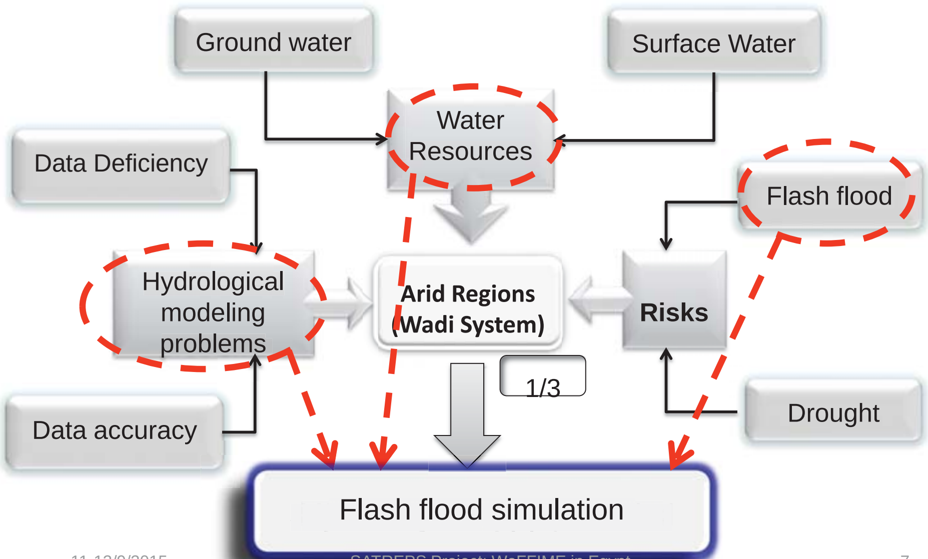
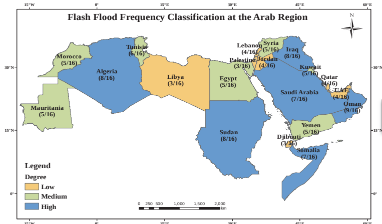
Introduction and problem statement

Wadi System Problems



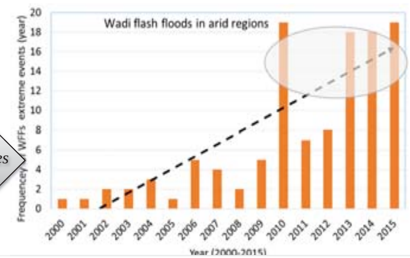
Recent Wadi Flash Floods Impacts in Egypt

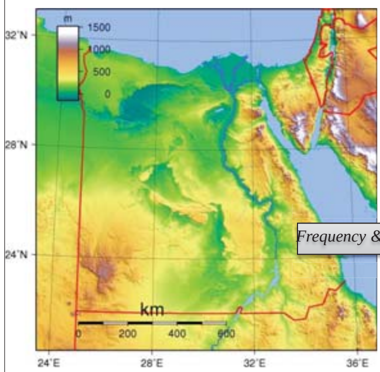
Flash Floods Frequency and Intensities



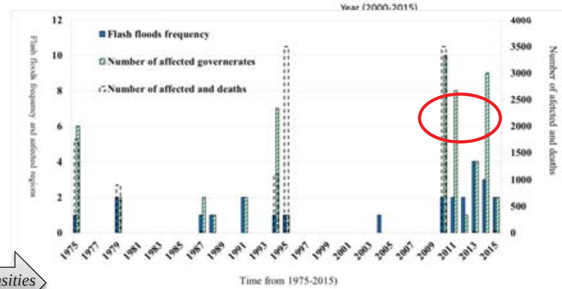
Flash flood frequency and classification at the Arab region

Frequency and intensities





Frequency & intensities



Why ? the frequency and intensities are increasing (2010-2016)

Climate Change?; Human activities?

Probability Risk analysis for Natural disasters in Egypt

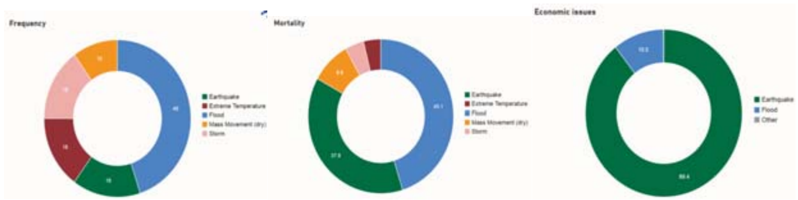


Fig. for frequency, mortality and economic losses resulting from natural disasters
http://www.preventionweb.net/countries/egy/data/,

Probabilistic risk results (http://www.preventionweb.net/countries/egy/data/), Average Annual Loss (AAL) by hazard.

Hazard	Absolute [Million US$]	Capital stock [%]	GFCF [%]	Social exp [%]	Total Reserves [%]	Gross Savings [%]
Earthquake	176.90	0.029	0.472	0.398	1.300	0.516
Tsunami	8.52	0.001	0.023	0.019	0.063	0.025
Flood	**161.27**	**0.026**	**0.430**	**0.363**	**1.185**	**0.471**
Multi-Hazard	346.69	0.056	0.925	0.781	2.548	1.012

CRED EM-DAT (Feb. 2015) : The OFDA/CRED - International Disaster Database www.emdat.be Université catholique de Louvain Brussels - Belgium.

Flash Floods Disaster Impacts

January 2010

November 2015

October 2016

SATREPS Project

Kyoto University Activities and progress

2006

Activities *and* *progress*

2017

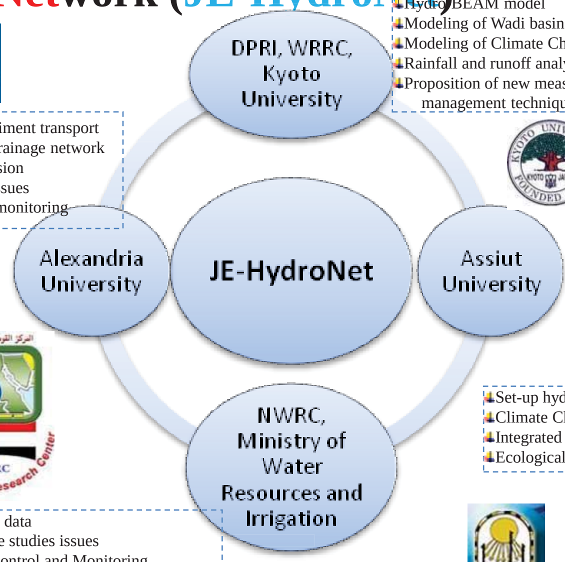
Wadi **F**lash **F**loods **I**ntegrated **M**anagement in **E**gypt by Considering Climate Change for Secured Development in Wadi Basins (**WaFFIME**)

JE-HydroNet

Establishment of Collaboration Japan Egypt Hydro Network (JE-HydroNet)

- General coordinator
- Hydro BEAM model
- Modeling of Wadi basins and Ground Water
- Modeling of Climate Change Adaptation scenarios
- Rainfall and runoff analysis
- Proposition of new measures for sediment management techniques

- Coastal and sediment transport
- Irrigation and drainage network
- Salt water intrusion
- Ground water issues
- Validation and monitoring



- Set-up hydrological modeling
- Climate Change Adaptation
- Integrated water resources management
- Ecological and biological issues

- Sharing available data
- State of art for the studies issues
- Measurements, Control and Monitoring
- Hydrological and meteorological measurements
- Facilitate accessing to the River, and dam sites

Japan Egypt Hydro Network (JE-HydroNet): Modern Methodologies for the Management, Monitoring and Planning of Integrated Water Resources in Nile Delta

First Mini-Symposium

October 26th (Tuesday), 2010

Salle D1518, Uji campus, Kyoto University

Organized by Water Resources Research Center, Disaster Prevention Research Institute, Kyoto University

- Impacts of climate changes on the Nile Basin and the Delta of Egypt
- Integrated water resources managements including irrigation and ground water
- Reservoir sustainability management
- Coastal management
- Flash flood disaster management

The Second JE-HydroNet Symposium on the Nile River System and the Delta of Egypt

Date : March 20-21, 2012

Venue :

German University in Cairo, GUC

The First International Symposium on Flash Floods in Wadi Systems (ISFF)

Organized by GADRI and WRRC

14th – 15th of October 2015, Kihada Hall, Uji campus, Kyoto University, Japan

The Second International Symposium on Flash Floods in Wadi Systems (2nd ISFF)

Organized by TUB

25 – 27 October 2016 Technische Universität Berlin, Campus El Gouna, Egypt

The Second International Symposium on Flash Floods in Wadi Systems (3rd ISFF)

Organized by TUB

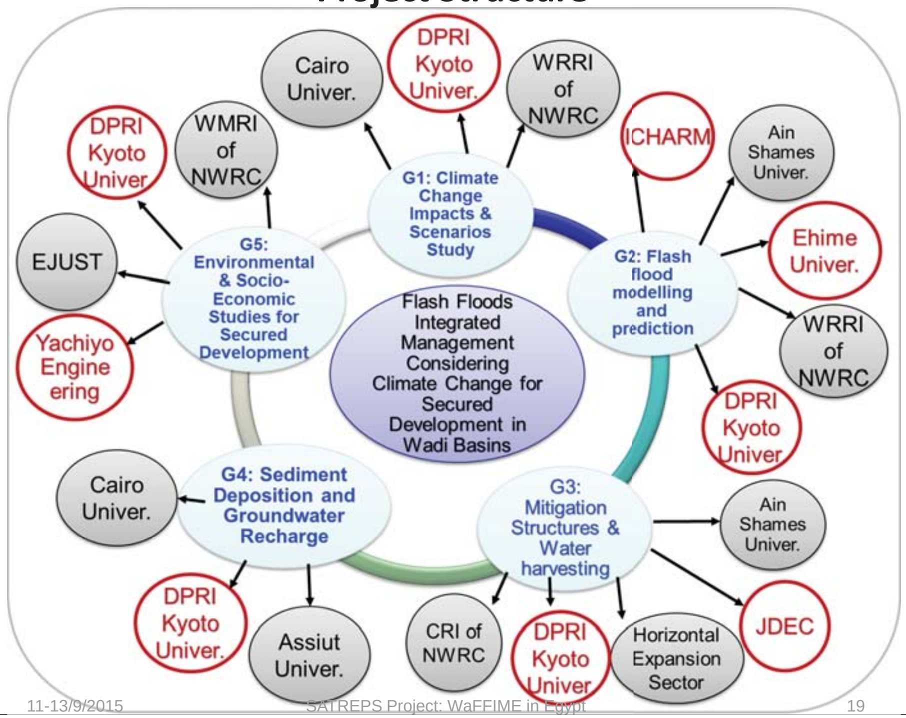
5 – 7 December 2017, German University of Technology in Oman (GUtech), Muscat, Sultanate of Oman: http://isff2017.gutech.edu.om/

Wadi Flash Floods Integrated Management in Egypt by Considering Climate Change for Secured Development in Wadi Basins (WaFFIME)

Research Groups and Institutes

Japanese Counterparts	Egyptian Counterparts	List of Groups
Kyoto University (DPRI)	NWRC- Water Resources Research Institute (WRRI), Construction Research Institute (CRI), Water Management Research Institute (WMRI)	G 1: Climate Change G 2: Flash flood modelling and forecast G 3: Mitigation of flood disasters G 4: Sediment Deposition and Groundwater Recharge G 5: Environmental and Scio-economic
Ehime University	Ain Shams University	
International Centre for Water Hazard and Risk Management (ICHARM)	Cairo University	
Japan Dam Engineering Center (JDEC)	Assiut University	
Yachiyo Engineering	Egypt-Japan University of Science and Technology (E-JUST)	

Project Structure



Project Objectives

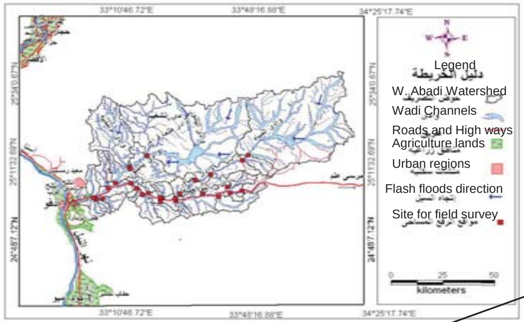
Overall Goal:

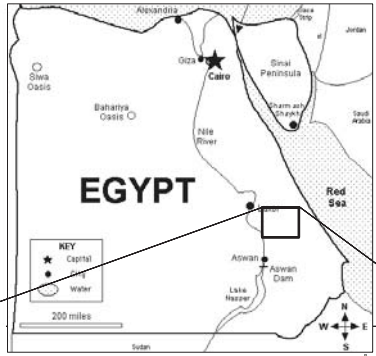
Transferring and implementing the developed WFF approaches and technologies to Wadi Abadi and other Wadis in Egypt

Project Purpose:

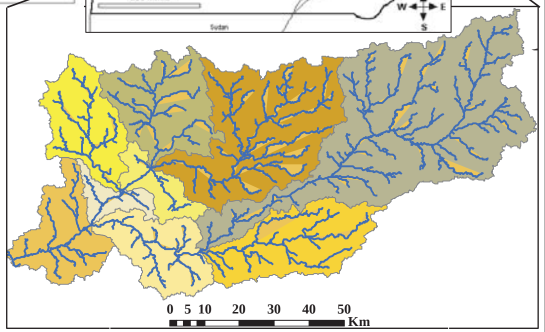
To develop an integrated sustainable system of Wadi Flash Floods (WFF) forecasting, mitigation, water harvesting and sediment management considering climate changes for secure development at wadi Abadi in Egypt

Traget Wadi Basin



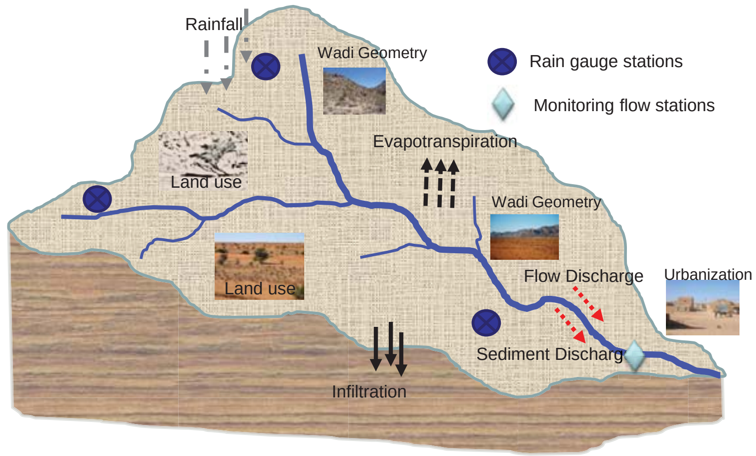


- Wadi Abadi is located in the Eastern Desert of Egypt between latitudes 24° 52' - 25° 37' N and longitudes 32°53' - 34° 15' E.
- It is bounded by the Red Sea and the Gulf of Suez from the east, and the River Nile valley from the west.
- Total area is approximately equal to 6,800 km².



Map of Egypt and location of W. Abadi

Implementation and Monitoring



Wadi Catchment Pilot Structure (Saber, 2017)

Project Expected Outcomes

Group 1:
Assessment of climate change impact on WFF in W. Abadi in Egypt is accomplished

Group 2:
Development of flash flood forecasting system using hydrological models and satellite-based rainfall and implementation is achieved

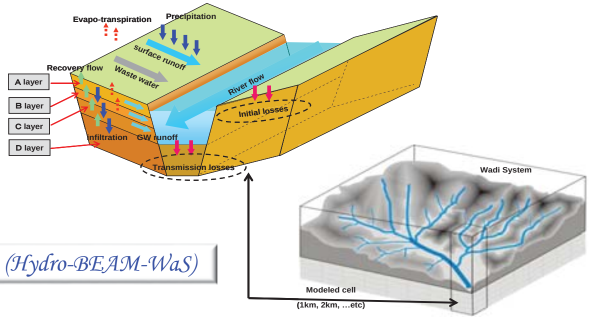
Group 3:
installing of FF mitigation structures throughout implementing and transferring the new technology of CSG Dam is conducted

Group 4:
Influence of Reservoir Sedimentation on Infiltration and Groundwater Recharge in Wadi Systems is performed

Group 5:
A public awareness and education system in order to reduce the flash floods disaster risks in wadi system is developed

Hydrological Approaches of wadi system and Applications

Hydrological Approaches and Applications at Wadi system



Hydro-BEAM
(Hydrological river Basin Environment Assessment Model)

Hydro-BEAM incorporating Wadi system (Hydro-BEAM-WaS)

Conceptual model of Hydro-BEAM (after; Kojiri, et al. (1998) and Saber et al. 2010)

Model components

- Kinematic wave Model (Surface flow)
- Linear storage model (Subsurface flow)
- Geographical Data SRTM (100m); GIS
- SCS Method (Initial loss)
- Meteorological Data NCDC or GSMaP
- Walter's Eq. (Transmission Loss)

Hydro-BEAM Model

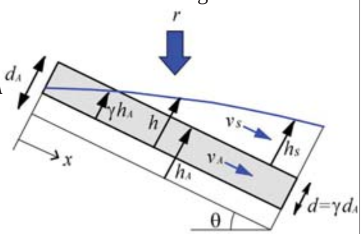
Mass conservation equation

$$\frac{\partial h}{\partial t}+\frac{\partial q}{\partial x}=r(x,t)$$

where
h is water depth [m]
q is discharge per unit length of flow [m³/m.s]
r is effective rainfall intensity [m/s]
t is time [s]
x is distance from the upstream edge
α, m is constant concerning friction

Layer A is governed by kinematic wave model

$$q_{Al}=\begin{cases}\alpha(h_{Al}-d_A)^{m_b}+ah_{Al}\\ ah_{Al}\end{cases},\quad when\ \begin{cases}h_{Al}\geq d_A\\ h_{Al}<d_A\end{cases}\quad d_A=\lambda_A D_A$$

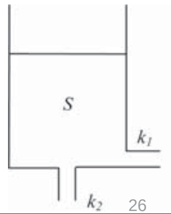


$$\alpha=\frac{\sqrt{\sin\theta}}{n}\ \text{(Manning-based)},\quad a=\frac{k\sin\theta}{\lambda_A}\ \text{(Darcy-based)}\quad m=5/3$$

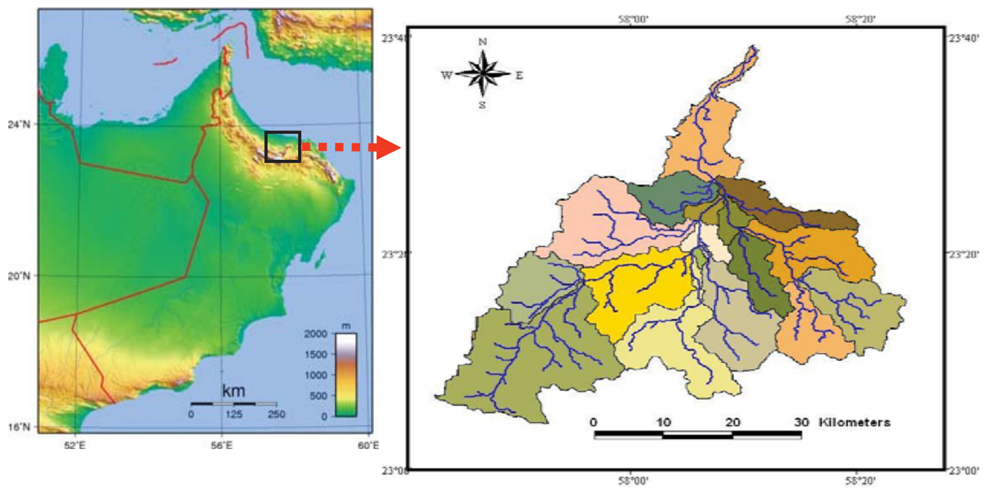
B, C, D layers are governed by the linear storage model

$$\frac{dS}{dt}=I-O\qquad O=(k_1+k_2)\cdot S$$

where
S is storage amount [m]
I is inflow [ms⁻¹]
O is outflow [ms⁻¹]
k_1 , k_2 is outlet coefficient.



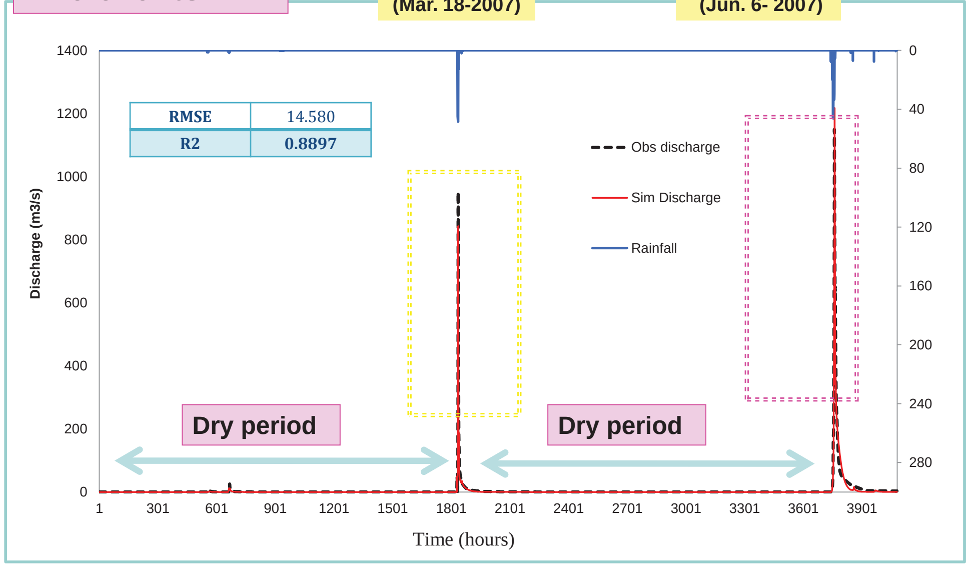
Calibration and Validation of HydroBEAM at Wadi Al-Khoud (Oman)



W.Alkhoud Area : 1874.84 Km²

Saber et al., 2010

Calibration and Validation of HydroBEAM at Wadi Al-Khoud (Oman)



Saber et al., 2010, 2015

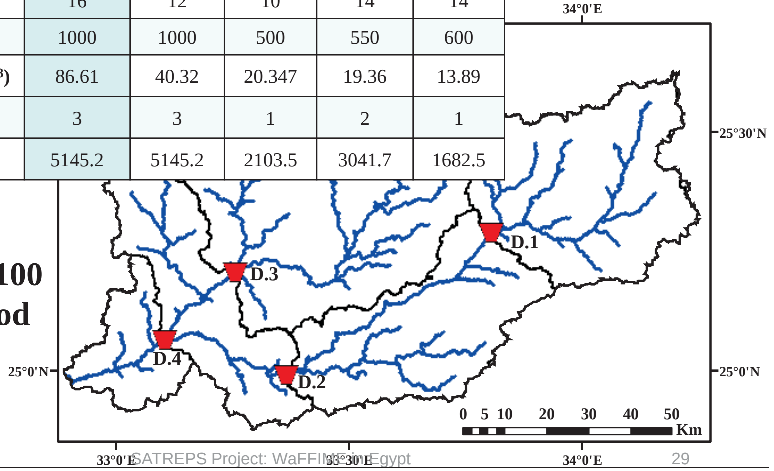
-59-

Flash Flood Mitigation Scenarios

- **Using 4 distributed dam vs 1 concentrated dam:**

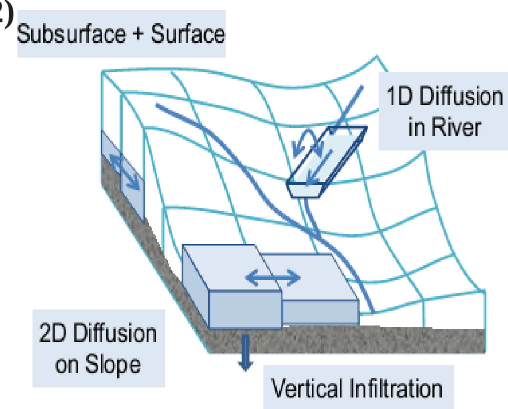
Characteristics of the proposed dams					
	D4 (Conc.)	D4 (Dist.)	D3 (Dist.)	D2 (Dist.)	D1 (Dist.)
Height (m)	16	12	10	14	14
Length (m)	1000	1000	500	550	600
Reservoir volume (*10^6 m^3)	86.61	40.32	20.347	19.36	13.89
Outlets (2.5*3m) number	3	3	1	2	1
Upstream area (km^2)	5145.2	5145.2	2103.5	3041.7	1682.5

Design storm: 100 yr return period



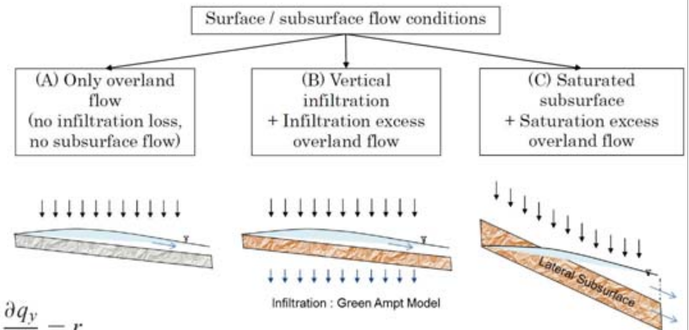
Rainfall-Runoff-Inundation (RRI) Model

- **RRI model is a two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously (Sayama et al., 2012)**



RRI model scheme overview (Sayama, T., 2013)

RRI Model



Mass Balance eq.

$$\frac{\partial h}{\partial t}+\frac{\partial q_x}{\partial x}+\frac{\partial q_y}{\partial y}=r$$

Momentum eq.

$$\frac{\partial q_x}{\partial t}+\frac{\partial u q_x}{\partial x}+\frac{\partial v q_x}{\partial y}=-gh\frac{\partial H}{\partial x}-\frac{\tau_x}{\rho_w}$$

$$\frac{\partial q_y}{\partial t}+\frac{\partial u q_y}{\partial x}+\frac{\partial v q_y}{\partial y}=-gh\frac{\partial H}{\partial y}-\frac{\tau_y}{\rho_w}$$

Diffusion Wave approximation

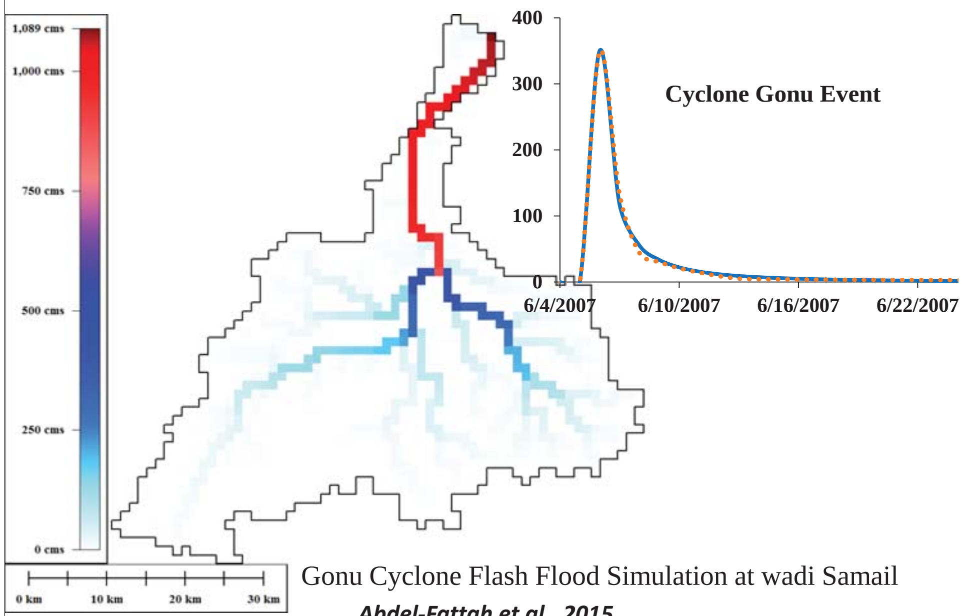
$$q_x=\begin{cases}-kh\frac{\partial H}{\partial x} & (h\le d)\\ -\frac{1}{n}(h-d)^{5/3}\sqrt{\left|\frac{\partial H}{\partial x}\right|}\operatorname{sgn}\left(\frac{\partial H}{\partial x}\right)-k(h-d)\frac{\partial H}{\partial x} & (d<h)\end{cases}$$

$$q_y=\begin{cases}-kh\frac{\partial H}{\partial y} & (h\le d)\\ -\frac{1}{n}(h-d)^{5/3}\sqrt{\left|\frac{\partial H}{\partial y}\right|}\operatorname{sgn}\left(\frac{\partial H}{\partial y}\right)-k(h-d)\frac{\partial H}{\partial y} & (d<h)\end{cases}$$

h water height from local surface,
$Q_{x,y}$ unit width discharges,
u & v flow velocities,
r rainfall intensity,
H water height from the datum,
ρ_w water density,
g gravitational acceleration,
τ_x and τ_y shear stresses and
n Manning's roughness
k lateral saturated hydraulic conductivity
d soil depth times effective porosity

(Sayama et al., 2012)

Results of Flood Surface Runoff

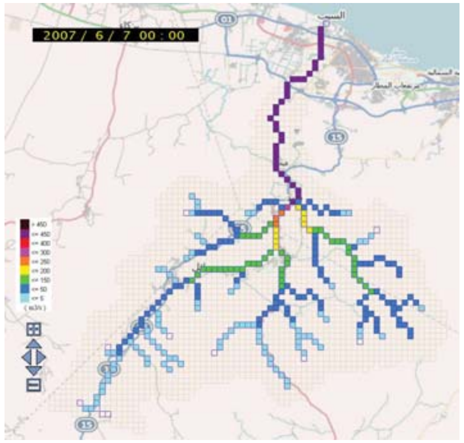


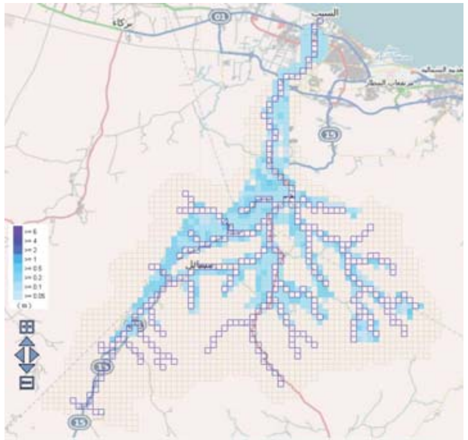
Gonu Cyclone Flash Flood Simulation at wadi Samail

Abdel-Fattah et al., 2015

Flash Flood Inundation Simulation

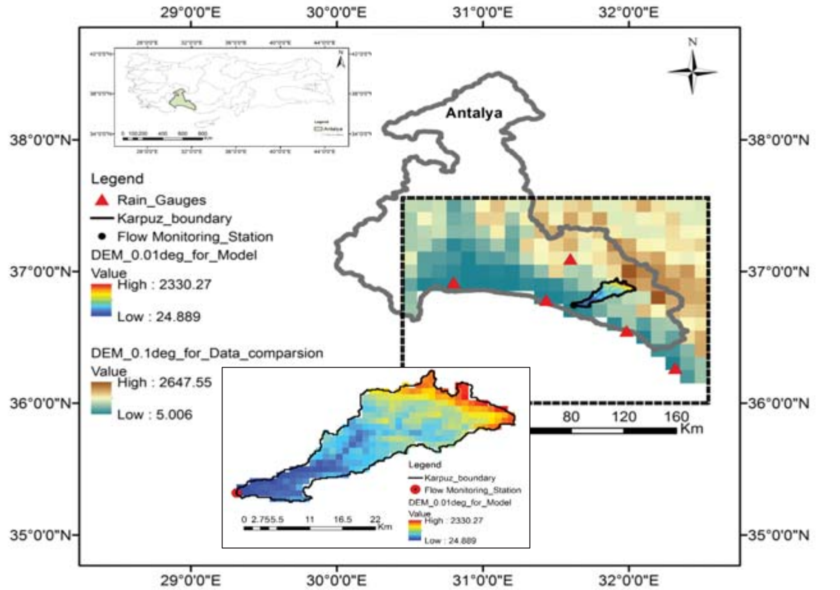
Discharge vs Inundation





Abdel-Fattah et al., 2015

Bias Correction of Satellite-Based Rainfall Estimates for Modeling Flash Floods



Saber, Mohamed, and K. Yilmaz. "Bias correction of satellite-based rainfall estimates for modeling flash floods in semi-arid regions: Application to Karpuz River, Turkey." *Nat. Hazards Earth Syst. Sci. Discuss* 2016 (2016): 1-35.

Distribution maps of Discharge

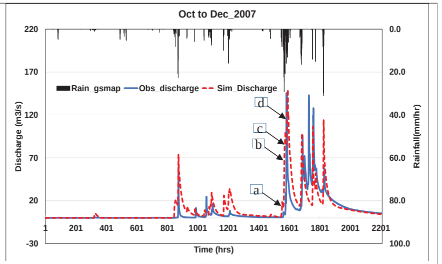
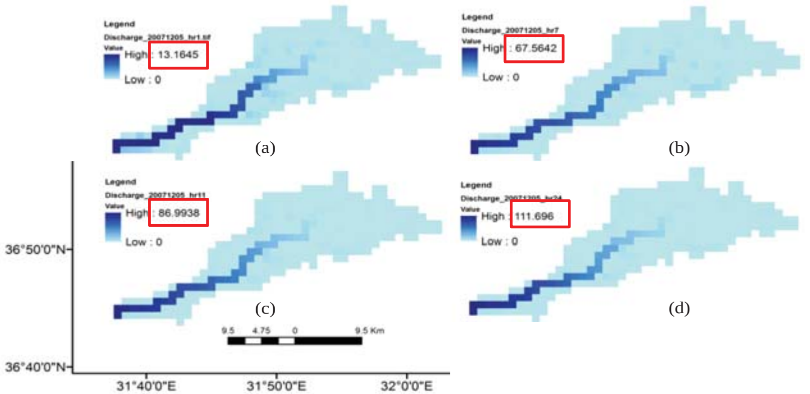


Figure Distribution maps of discharge at different hours: 20071205 (hour 1(a), 7(b), 11(c),



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Conclusions

Proposed concept for integrated multidisciplinary strategy for wadi system in arid regions

- Research teams
  - National level
  - Global level
- Data bases
  - Global Data
  - Observational data
- Invoative approaches
  - Avaiable models
  - Required Upgrading
- Risk reduction and sediment management
  - Mitigation missures
  - Hazard assessment
- Society and environment
  - Society Contirbuation
  - Envroiment al Impacts
- Decision making, planning, and governance
  - Current plan and policy
  - Future plan

Conclusions: Key questions

- What are the available national and global networking for research collaboration?
- What do we need to initiate such important networks from different countries involving researchers, engineers, professionals, stakeholders, society, etc.?
- What are the available meteorological data and other data?
- If not, what we should do to overcome the problem and build the database for wadi system?
- What are the missing in the current developed models for wadi flash floods?;

Conclusions: Key questions

- How can we fill the occurred gabs in terms of modelling, forecasting and mitigation, based on understanding the flash floods phenomena?
- How can we come up with WFF risk reduction using the effective hydrological models and mitigation measures?
- How can we manage the associated sediments with flash floods
- How can we contribute in wadi society and community development?
- How can we involve the society in the research and projects implementation?

Conclusion

- The answers about these questions are the only and optimal way to overcome water related problems in wadi system for society development and environmental protection.
- The current and previous improvements, the gaps and missing in research and technologies, and our contributions and development **could be achieved by the proposed integrated approach**.
- Working together in groups under the same umbrella **is the way forward to overcome such challenge**s and come up with building of database, new modelling approaches, water and sediment management, disaster risk reduction, wadi society development and environmental protect.

Conclusion

- Implementation the mitigation measures and harvesting structures, integration between this multidisciplinary themes, transferring knowledge and technologies, involving of wadi society in research (collecting data and implementation), developing public awareness and educational system ***are the main unique merits of such integrated strategy*** **= = = >**

SATREPES Project of WaFFIME


Thank you
for your attention
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11-13/9/2015
SATREPS Project: WaFFIME in Egypt
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