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J-RAPID

Field Survey and Development of GIS Database on Rural Areas Affected by the Nepal Earthquake

Final Report on 22 June, 2016

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collaborated with
Institute of Environmental Rehabilitation and Conservation

Composition of Research Team

- Japanese Team
  - Faculty of Regional Environment, Tokyo University of Agriculture
    (Principal Investigator: Machito MIHARA, Prof. Dr.)

    Collaborated with

    Research Center, Institute of Environmental Rehabilitation and Conservation

- Nepalese Team
  - School of Engineering, Kathmandu University

    (Principal Investigator: Bim Prasad SHRESTHA, Prof. Dr.)

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Research Members (Japan)

Japanese Team (Faculty of Regional Environment Science, Tokyo University of Agriculture (TUA) collaborated with Institute of Environmental Rehabilitation and Conservation (ERECON)

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- Koji MIWA (TUA / ERECON)
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Research Director (DHM) and Japanese team

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Research Members (Nepal)

Nepali Team (Kathmandu University)

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- Sneha SHARMA, Research Assistant
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Nepali team

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Team Meeting

at Kathmandu University on 16 February, 2016

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Research Objectives

This research dealt with the analysis of the facts and features of devastation and the evaluation of land use in rural areas suffered from the Nepal Earthquake in April and May 2015 for building up the new GIS database

- To understand and analyze the damage on residential and other buildings as well as agricultural land and facilities
- To classify the rural areas into suitable land use type taking account of disaster risks
- To suggest the Nepalese Government high resilience area to natural disasters
- To recommend the government a sustainable land use plan for the rural areas

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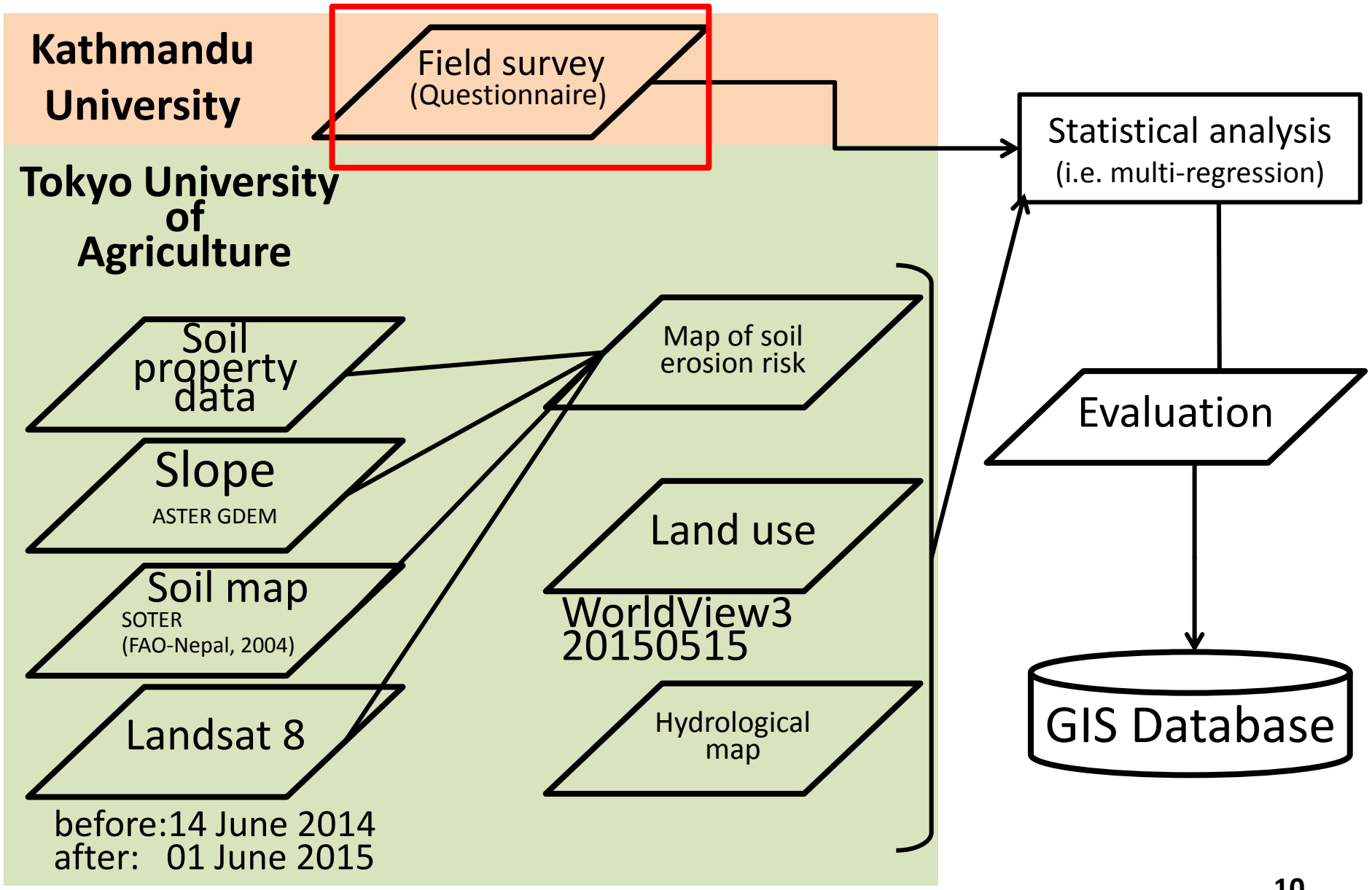
Expected Outcomes

It is expected that the Nepalese Government could identify what aid and reconstruction plan is proper and needed in the project sites to make the rural societies more resilient to natural disasters and sustainable

Research Flow and GIS Database



Field Survey

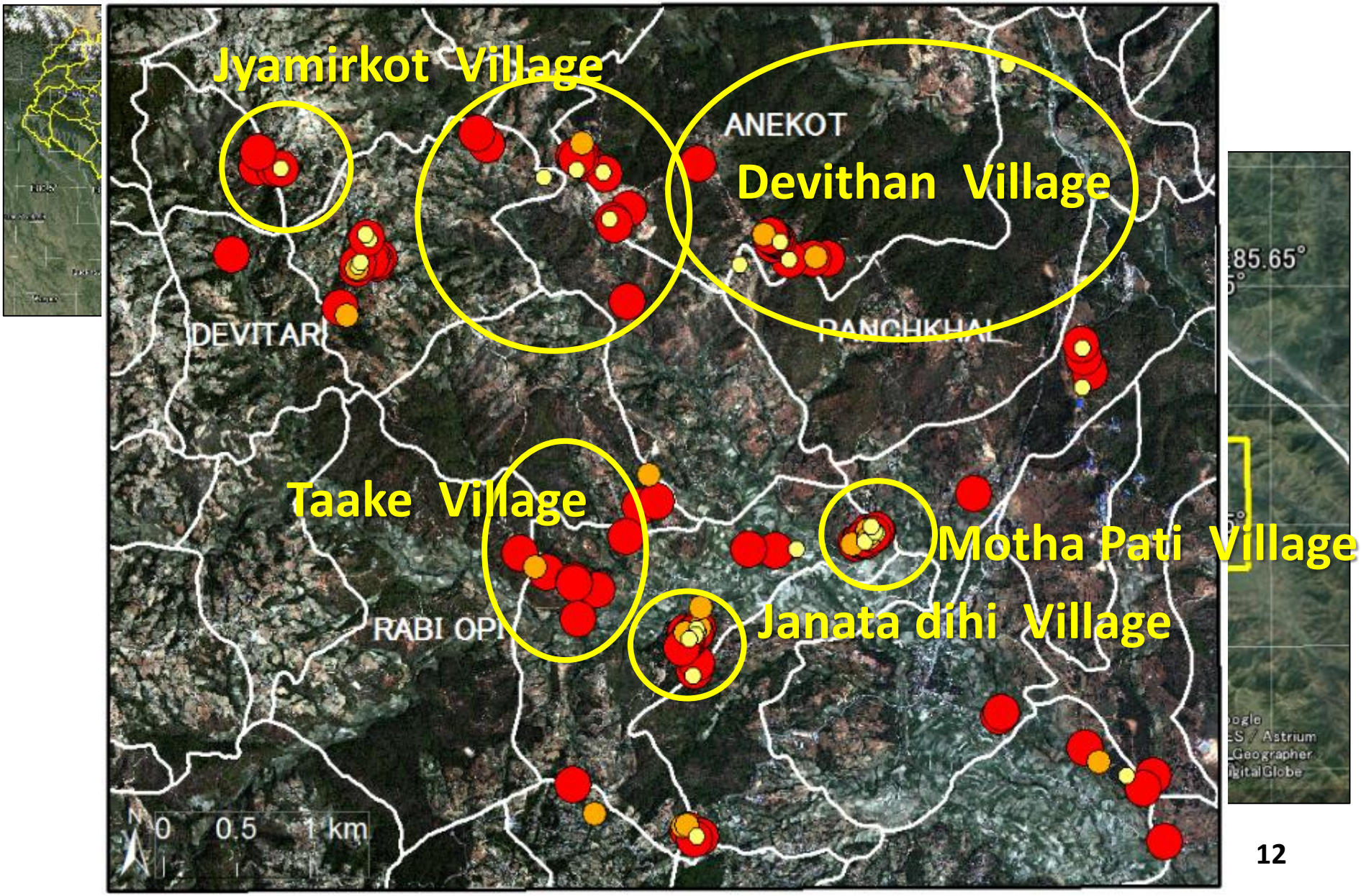
The survey has been conducted in 13 villages at the research site, Panchkhal and Anaikot areas in Kavrepalanchok District.

It included GPS data collection, field observation, soil sampling and questionnaire survey

- GPS data collected was reflected on GIS database
- Questionnaire survey was conducted to collect the data on damages of agricultural land and facilities as well as houses
- Soil sampling was conducted for soil erosion risk analysis

Research site

Panchkhal and Anaikot , Kavrepalanchok（13 villages）



Field observation

conducted from November 2015 to May 2016

at Motha Pati Village , Panchkhal

on 17 February, 2016

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Interview and hearing research

at Krishna Mandir Village, Anaikot

on 18 February, 2016

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Questionnaire survey

at Krishna Mandir Village, Anaikot

on 18 February, 2016

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Questionnaire survey

at Krishna Mandir Village, Anaikot

on 18 February, 2016

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Soil sampling

at Shikharpur Village (left) and Motha Pati Village (right),

Panchkhal on 17 February, 2016

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Devithan Village (Devithan=God's place)

- Seven people died
- 70% of total houses in the village were collapsed

Totally damaged house and barn

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Damaged houses and barns made of stones and muds

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Totally damaged house made of stones and muds

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Half damaged house

Partially damaged brick house

Damage was less compared to houses made of muds, stones or unbaked bricks, but this house was damaged as the next building fell down on

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Temporarily repaired house

Repairing is not enough to prevent cold air in winter

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Temporarily repaired house

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Temporary house

Temporary house

Jyamirkot Village

- Five people died and four of them were same family members
- Flat land is limited, thus houses are more scattered out compared to other villages

Totally damaged house and barn

Damaged houses and barns

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Totally damaged house

Totally damaged house and barn

Temporary houses

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Terrace rice field (no damage)

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Upland field cultivating tomato (no damage)

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Terrace fields (no damage)

Other villages

Half damaged house and barn

at Nayagaon Village

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Totally damaged houses and barns

at Krishna Mandir Village

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Facility for spring water source
at Shikharpur Village

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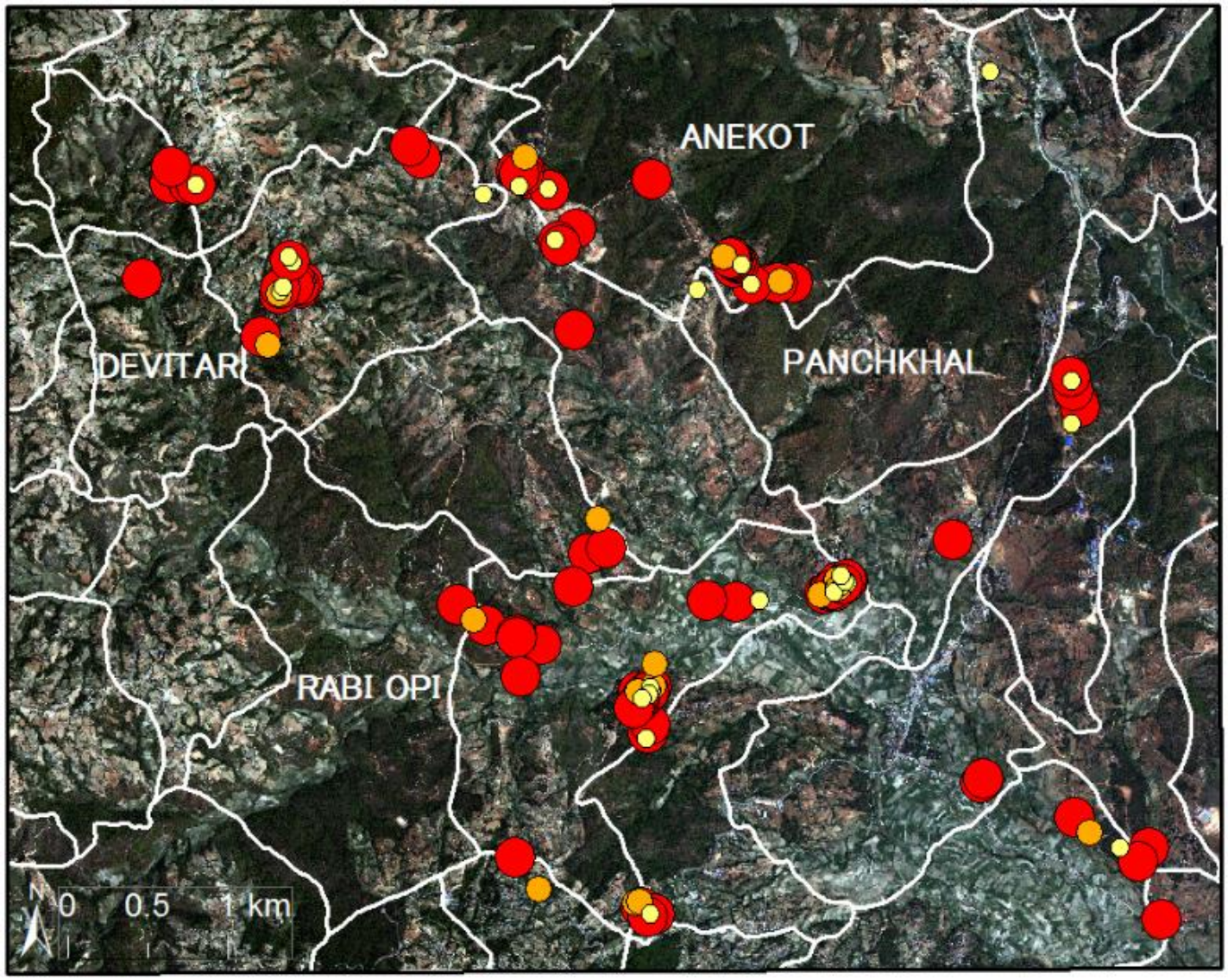
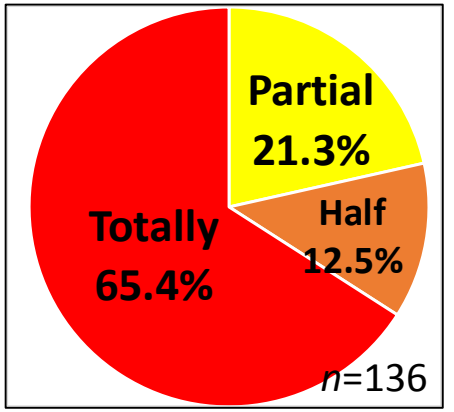
Damage map of houses and barns



Damage
- Partially
- Half
- Totally



Findings from Field Survey (1)

- In most of villages, farmers mentioned that soil became dry after the earthquake

- In some villages, water sources became less and villagers have to draw from other points. Some of them could find the alternative source but especially ones located in high upland have not been able to find and have to depend on rainfall. However, due to the lack of precipitation, their daily life is so hard

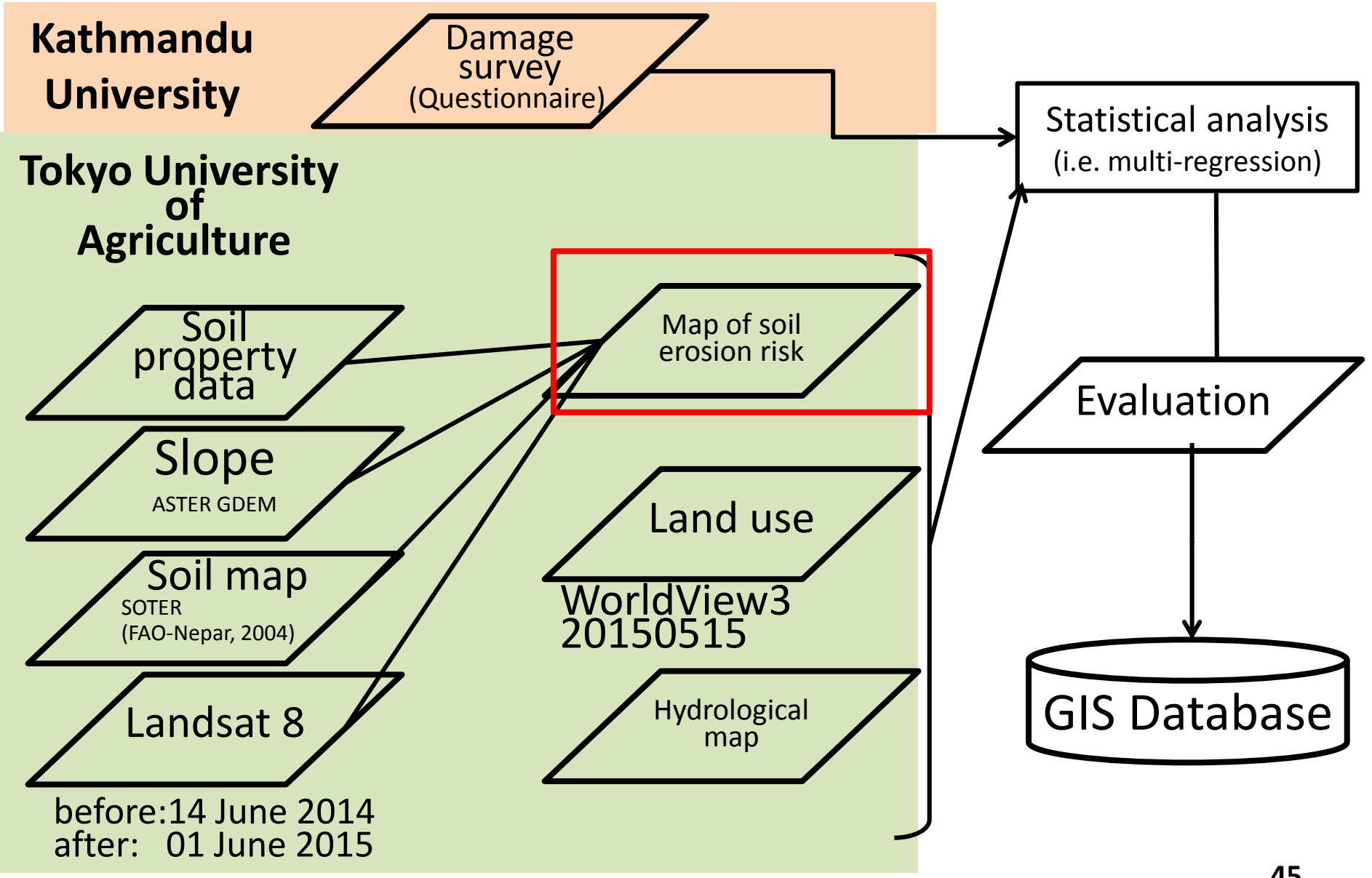
Findings from Field Survey (2)

- Agricultural land was not damaged by the earthquake directly except for water shortage

- Building structures such as houses and barns were significantly damaged as well as losses of livestock

- Most of collapsed houses were made of unbaked bricks, stones or muds. The aids delivered to those victims are not enough to reconstruct their houses, and they are sleeping outside, because they are afraid of further breakdown of house

Research Flow and GIS Database



Soil Erosion Risk Analysis

Although remarkable damages in agricultural fields were not observed through the field survey, attention has been paid on how field condition has changed after the earthquake

Based on USLE (Universal Soil Loss Equation), soil erosion risk was compared between before and after the earthquake. Vegetation cover conditions before the earthquake were taken on 14 June, 2014 and that after the earthquake on 01 June, 2015

Methodology

Calculation of soil erosion risk

Soil erosion risk (SER) = K * LS * C

K : soil erodibility factor
LS : topographic factor
C : cropping management factor

K factor

$$K = 2.1\ M^{1.14}\ 10^{-4}\ (12\text{-}OM) + 3.25\ (b-2) + 2.5\ (c-3) / 100 / 7.59$$

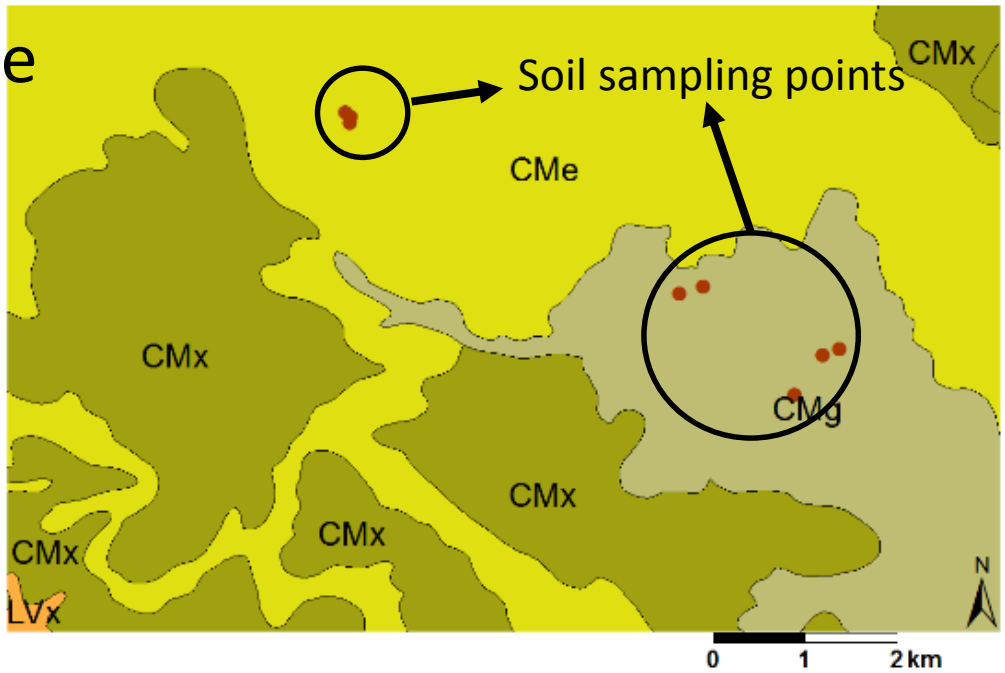
M : (% silt + % sand)* (100 - % clay)

OM : percentage of organic matter (%)

b : soil structural code

c : soil permeability code

Soil and Terrain Database:
SOTER (FAO-Nepal,2004)



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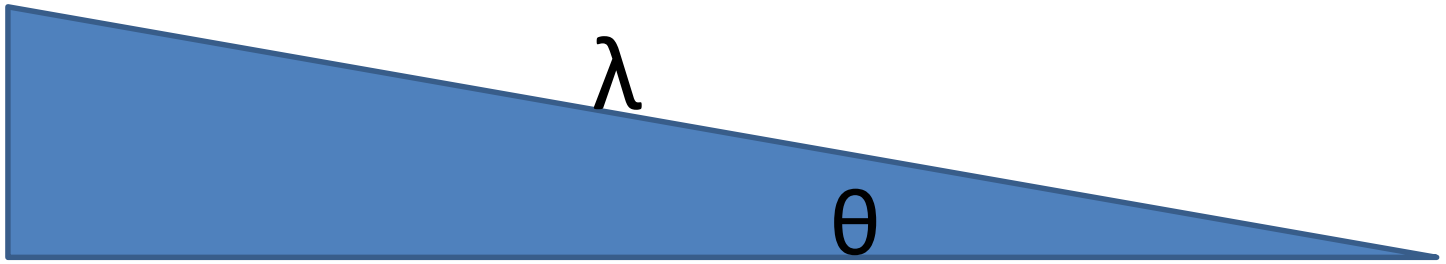
LS factor

$LS = (\lambda / 22.13)^{m} (65.41\sin^2\theta + 4.56\sin\theta + 0.065)$

λ : slope length (m)

θ : slope in degree (m=0.5)



C factor

$$C = -0.8158\ NDVI + 1$$

NDVI: Normalize Difference Vegetation Index

NDVI = (NIR-Red) / (NIR + Red)

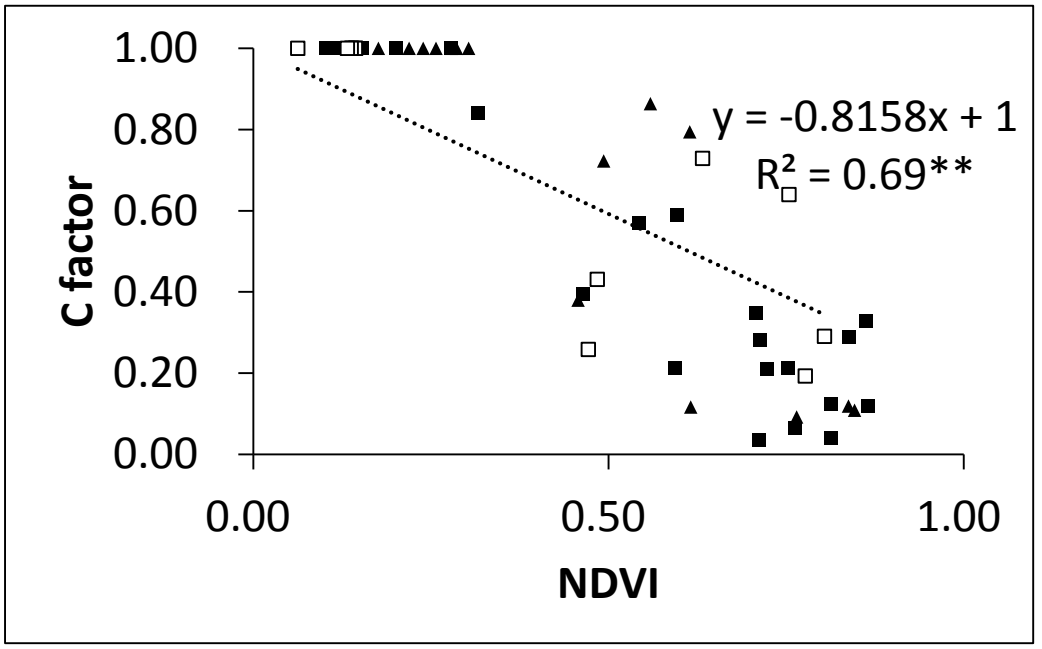
NIR: Near Infrared Red

Red: Visible Red

Landsat 8 OLI

Before: 14 June, 2014

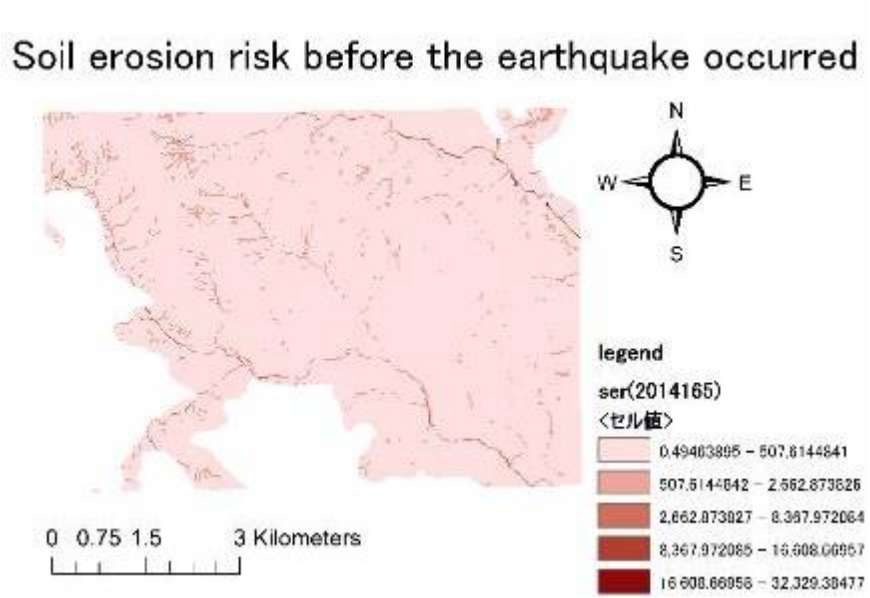
After: 01 June, 2015

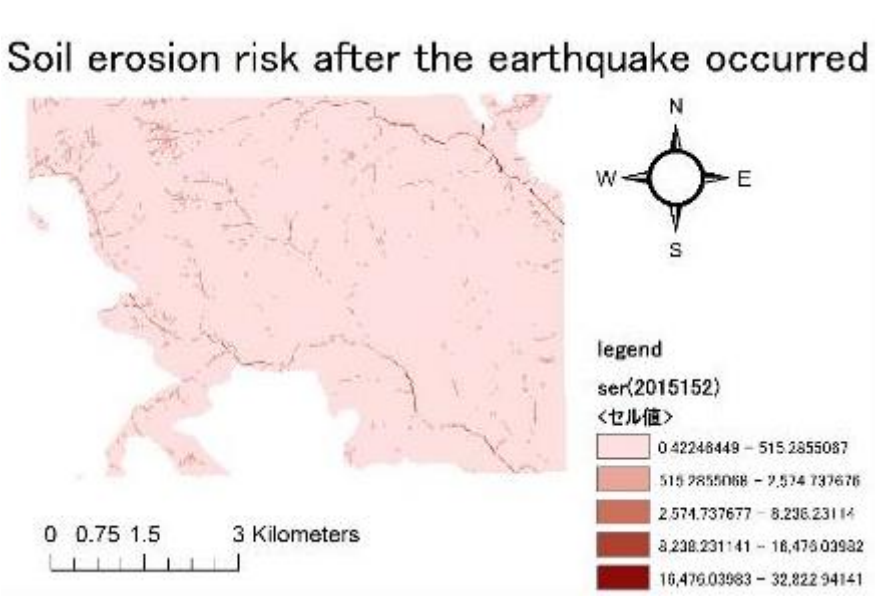


Relationship between C factor and NDVI from Landsat 8

Results and discussions

Soil erosion risk（SER）maps





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Comparison of SER before and after the earthquake

$$\text{VSER} = \frac{SER(A) - SER(B)}{SER(B)}$$

VSER - Changed value of soil erosion risk

SER (A) - Soil erosion risk after earthquake

SER (B) - Soil erosion risk before earthquake

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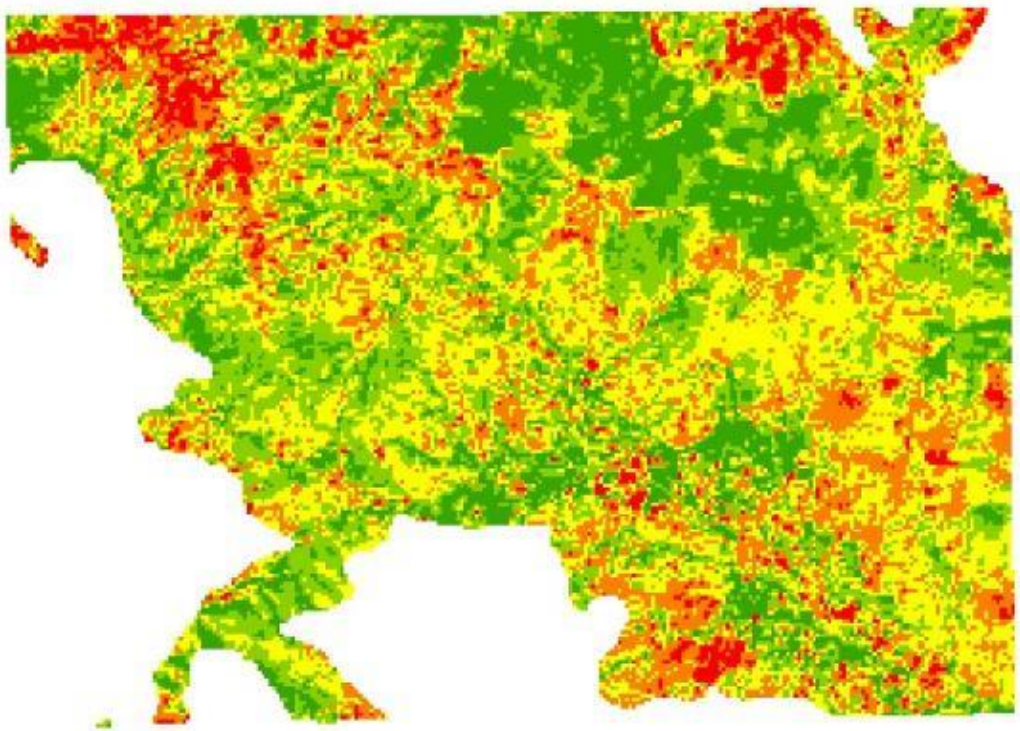
Changed value of soil erosion risk



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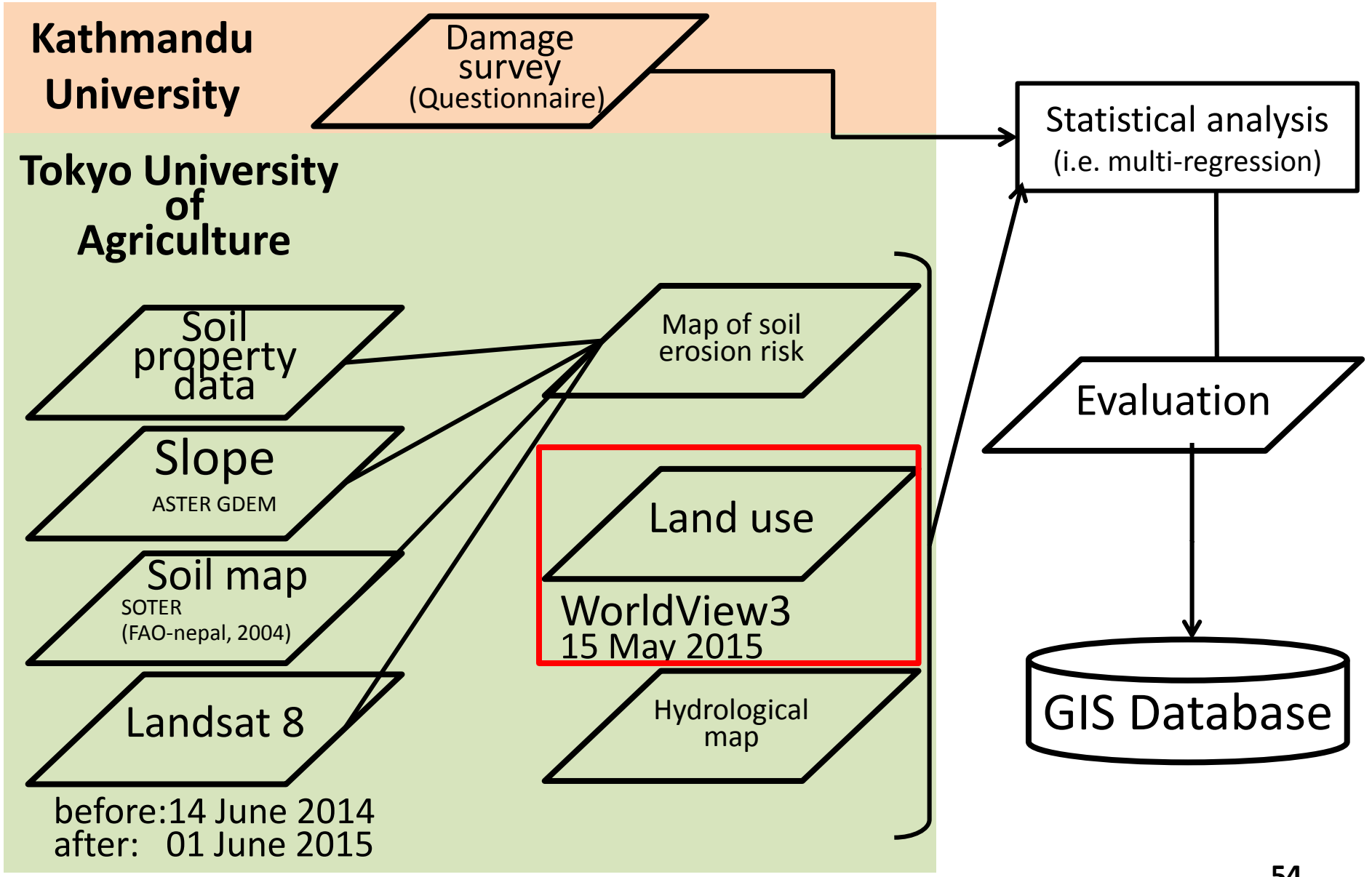
Research Flow and GIS Database



Land use (by digitizing)

WorldView-3

15 May 2015

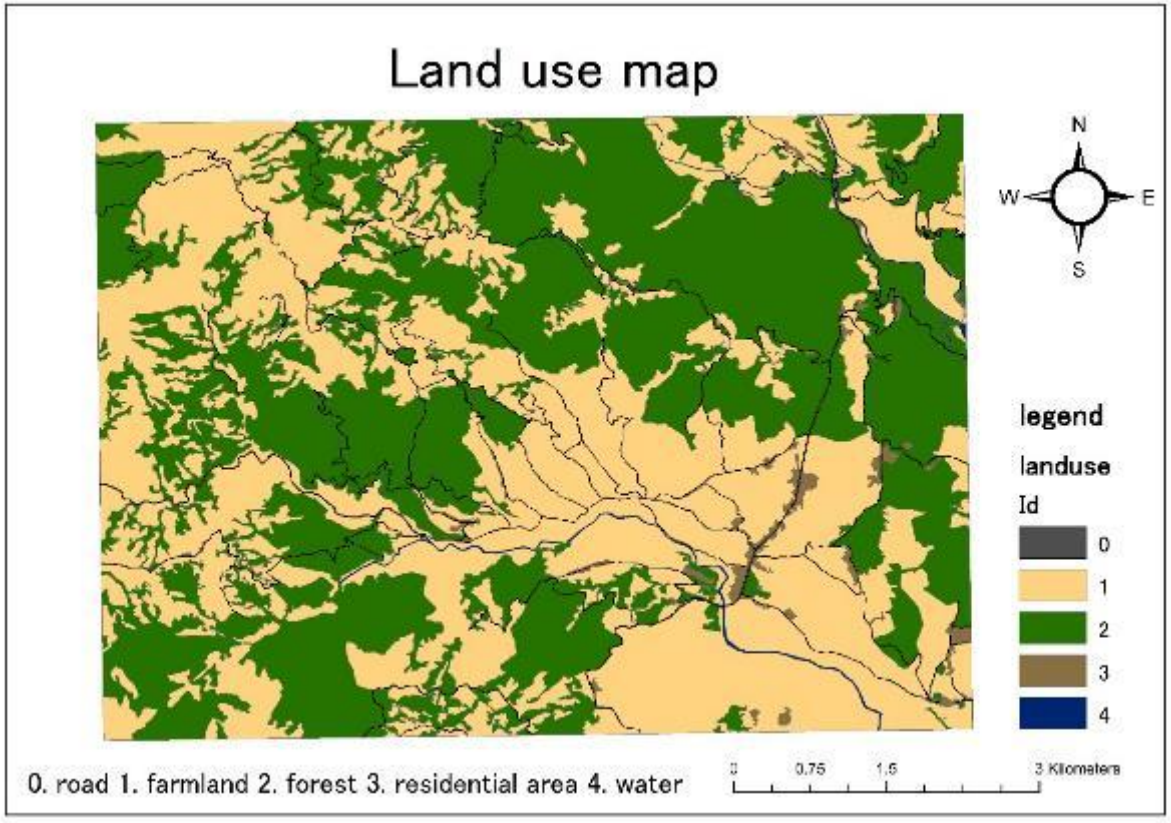
Road

Farmland

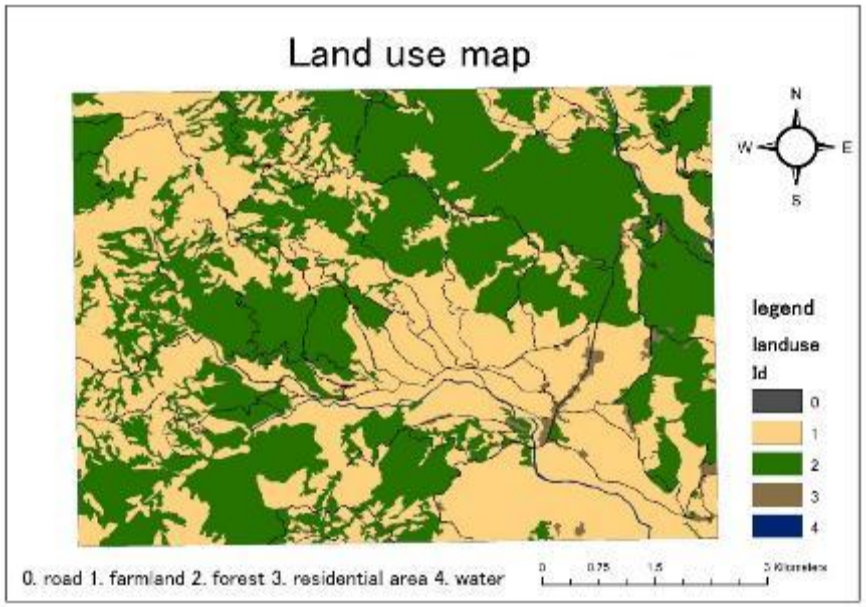
Forest

Residential area

Water



Land use classification



Road

Farmland

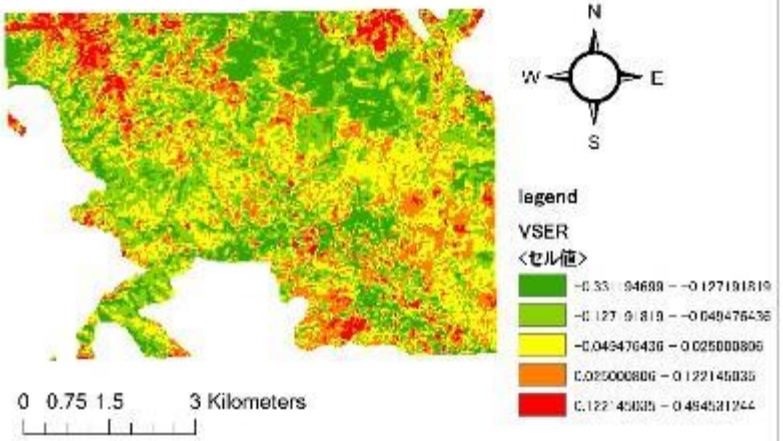
Forest

Residential area

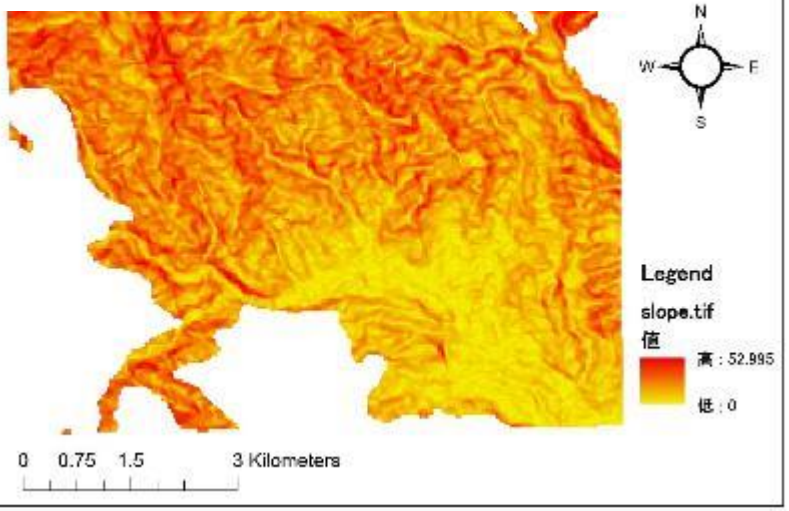
Water

	Legend	Total area (m^2)	%
	Road	622187.3	1.4
	Farmland	22758091.7	49.6
	Forest	21856806.3	47.7
	Residential area	465637.8	1.0
	Water	154092.5	0.3
Total		45856815.6	100

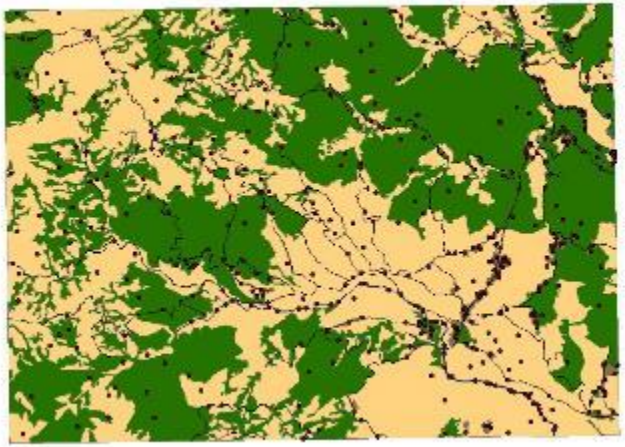
Changed value of soil erosion risk



Slope degree



Random points selected for analysis based on land use



Analysis

Pixel value of slope and VSER were extracted by random points

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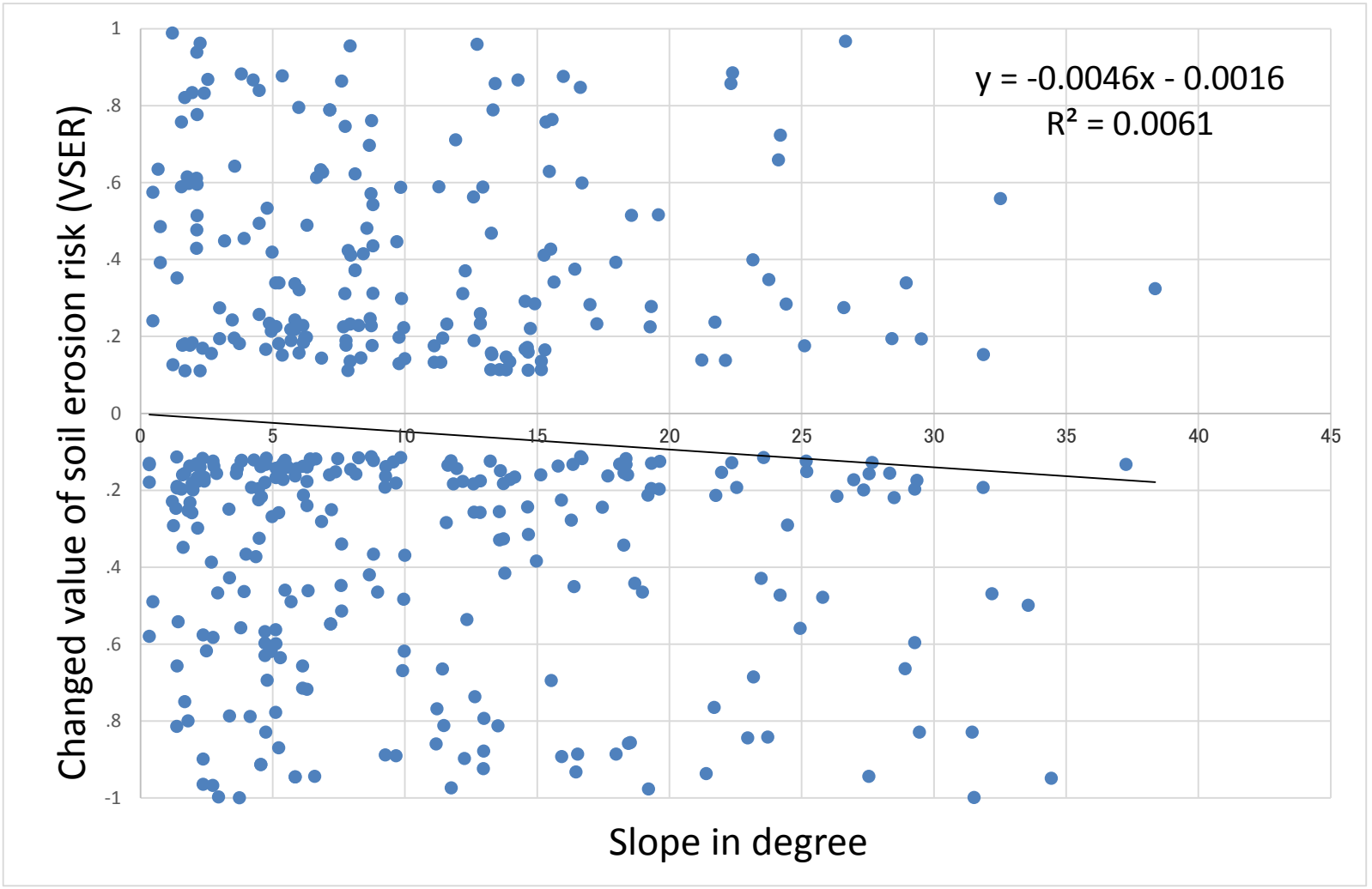
Relation between VSER and slope



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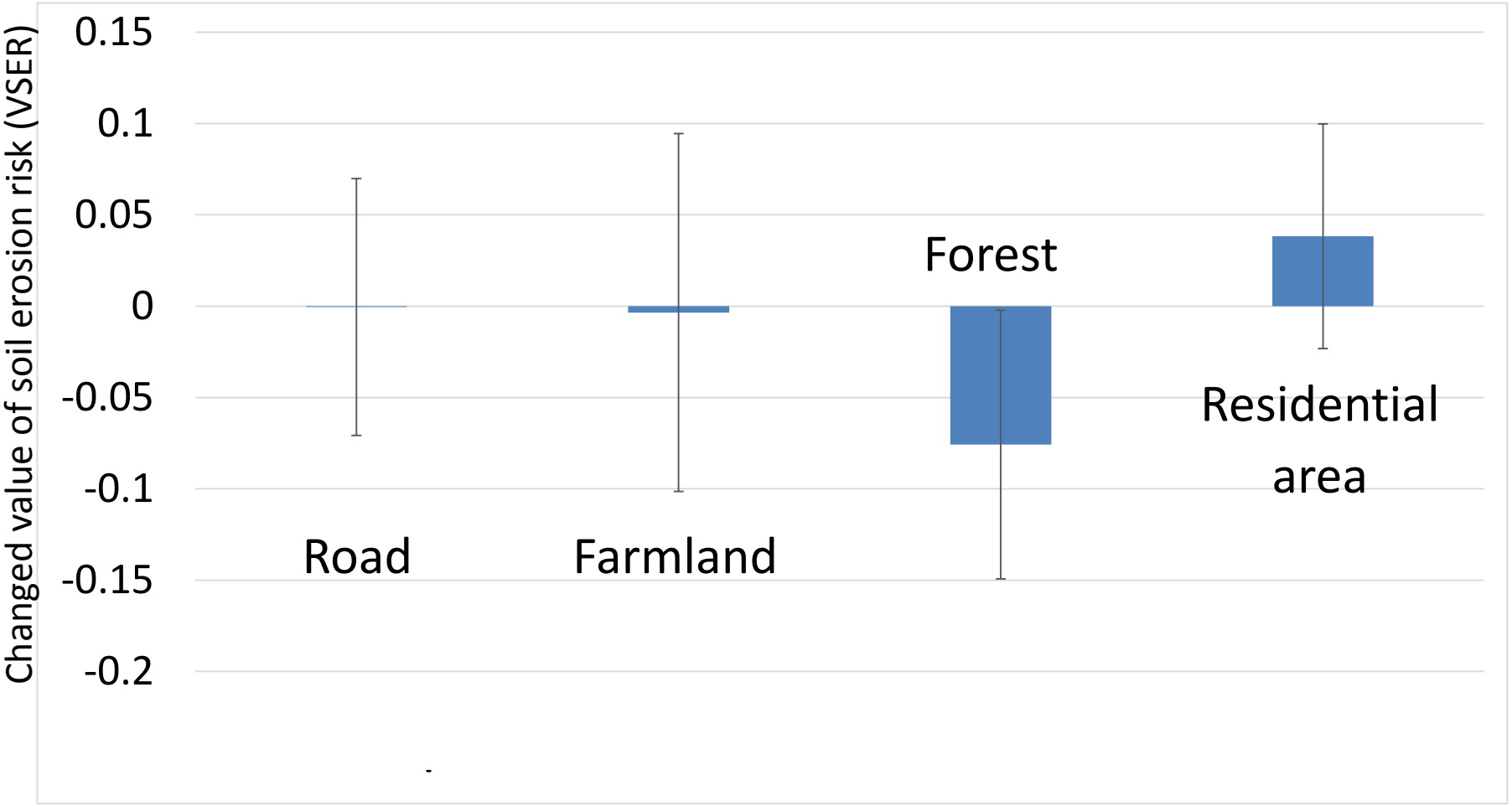
Changed value of soil erosion risk vs land use



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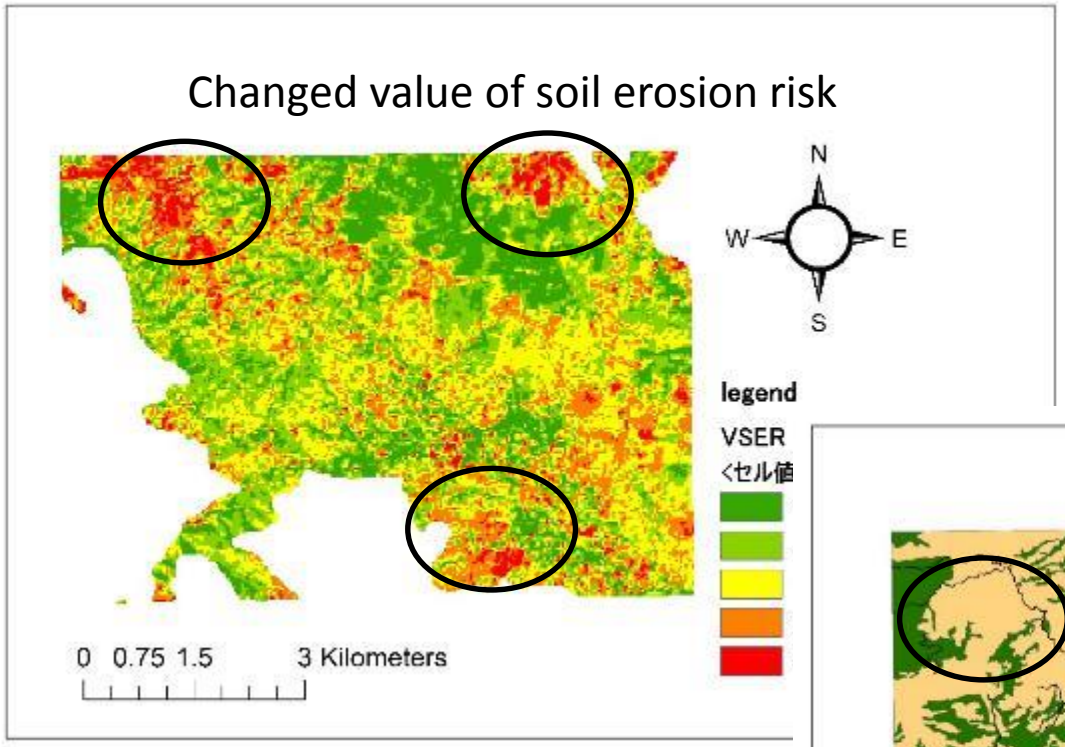
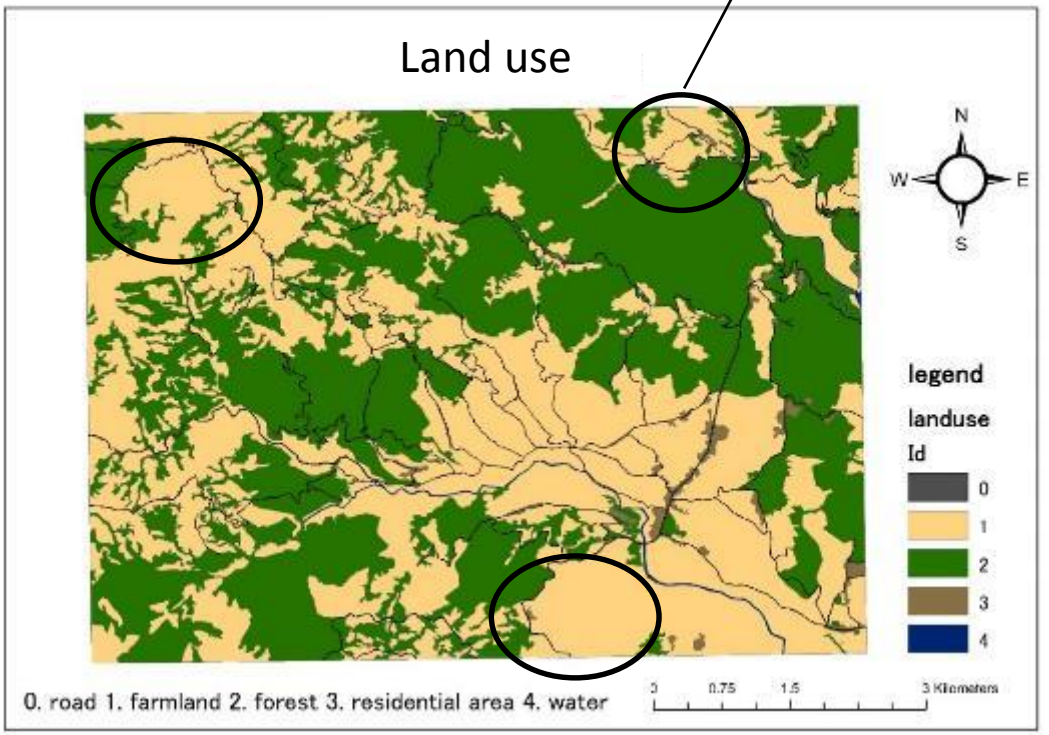
However….





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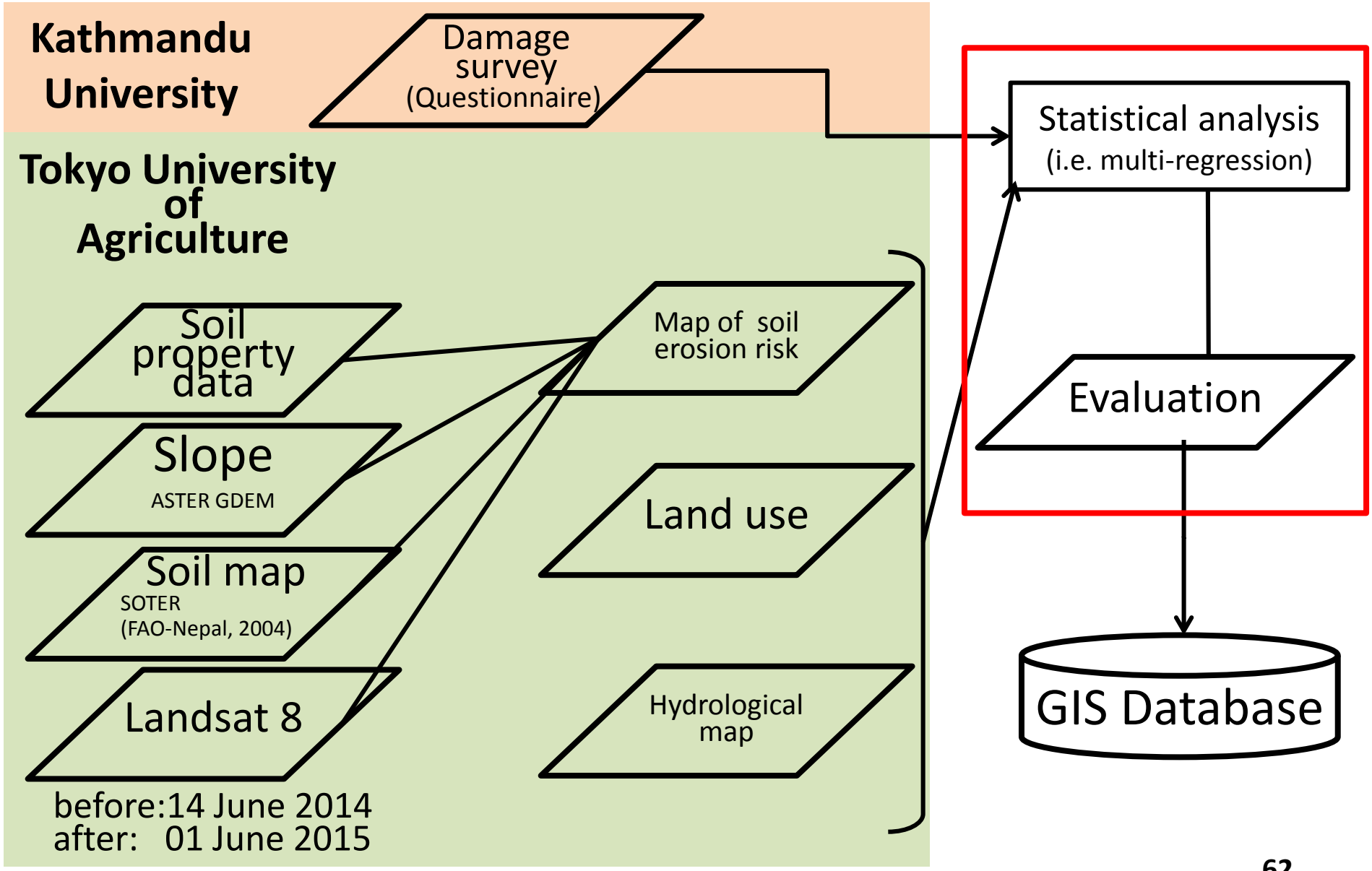
Findings from SER Analysis

- Based on USLE (Universal Soil Loss Equation), soil erosion risk was compared between before and after the earthquake
- Changed value of SER (VSER) was calculated to compare the difference in SER before and after the earthquake. There was no remarkable relationship between VSER and slope in degree
- In farmlands, the changed value of SER (VSER) was small. However, there were tendencies for VSER in residential area to increase and for forests to decrease
- Even in farmlands, the changed value of SER (VSER) increased after the earthquake in some area. Continuous observation should be conducted

Research Flow and GIS Database



Evaluating Dominate Factors

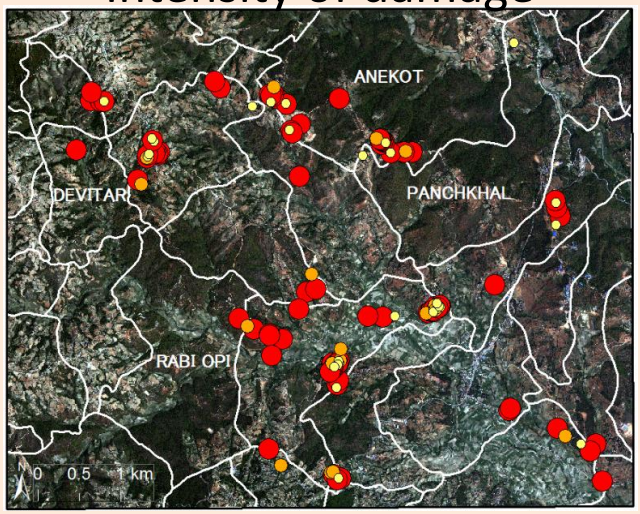
- Based on damage degrees of houses and barns, dominate affecting factors were analyzed with multi-regression analysis
- In multi-regression analysis, explanatory variables are ‘Age of a house’, ‘Building material type’, ‘Changed value of soil erosion risk’, ‘Land use type’, ‘Irrigation type’, ‘Slope in degree’, ‘Crop type’, ‘Farmland productivity’, ‘Elevation’, etc.
- All variables were obtained in this study through field survey, laboratory experiments and GIS analysis, in addition to collected data in Nepal

Evaluating dominate factors for damage

Multi-regression analysis

Objective variable

Intensity of damage



Explanatory variable

- Age of a house
- Building material type
- Variation soil erosion risk
- Land use type
- Irrigation type
- Slope in degree
- Crops type
- Farmland productivity
- Elevation ・・・ etc.

R=0.35

Explanatory variable	P value
Age of a house	0.0257 *
Elevation	0.0464 *
Farmland productivity	0.0519

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Findings from Dominate Factor Evaluation

- Dominate factors affecting to the damage degrees of houses and barns were analyzed by multi-regression analysis
- Based on the results of multi-regression analysis, the dominate factors were ‘Age of a house’ and ‘Elevation’ at 95% confidence interval
- Further analysis is necessary with other statistical methods

Tentative Concluding Remarks

Research Objectives

This research dealt with the analysis of the facts and features of devastation and the evaluation of land use in rural areas suffered from the Nepal Earthquake in April and May 2015 for building up the new GIS database

- To understand and analyze the damage on residential and other buildings as well as agricultural land and facilities
- To classify the rural areas into suitable land use type taking account of disaster risks
- To suggest the Nepalese Government high resilience area to natural disasters
- To recommend the government a sustainable land use plan for the rural areas

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Tentative Concluding Remarks (1)

To understand and analyze the damage on residential and other buildings as well as agricultural land and facilities

- Agricultural land was not damaged by the earthquake directly
- Building structures such as houses and barns were significantly damaged as well as losses of livestock
- Most of collapsed houses were made by unbaked bricks, stones or muds
- From the results of multi-regression analysis, the dominate factors were ‘Age of a house’ and ‘Elevation’ at 95% confidence interval

Tentative Concluding Remarks (2)

To classify the rural areas into suitable land use type taking account of disaster risks

- Based on USLE (Universal Soil Loss Equation), soil erosion risk was compared between before and after the earthquake. In farmlands, the changed value of SER (VSER) was small. However, there were tendencies for VSER in residential area to increase and for forests to decrease. Accordingly, it was concluded the vegetation cover is important to eliminate further erosion phenomena

Tentative Concluding Remarks (3)

To suggest the Nepalese Government high resilience area to natural disasters

- From the results of multi-regression analysis, the dominate factors were 'Age of a house' and 'Elevation' at 95% confidence interval. Also, there was a tendency in higher elevation indicated smaller damage and lower elevation larger damage. However, more detail analysis is necessary to conclude it

To recommend the government a sustainable land use plan for the rural areas

- From the results of soil erosion risk analysis, it was concluded the vegetation cover is important to eliminate further erosion phenomena

Future Research

- So far we observed, there was no certain trend in agricultural productivity. We would like to observe continuously how the productivity changes after the earthquake

Acknowledgements

- This research has been financially supported by JST (Japan Science and Technology Agency). Also, it was very grateful that JST members provided us very meaningful guidance and recommendation during our research in J-RAPID Nepal

- Related governmental organization in Nepal, especially DHM, kindly provided us statistical documents, maps and GIS data. Their kind collaboration was very appreciated. The database would be ready to open soon in TUA and KU website. Although our achievements are limited, we are very happy if the database is useful for reconstruction planning of damaged area

Thank you for your attention!

We do hope local livelihoods of people will be improved soon

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