GIS手法・InSAR変位量を用いた 2007年能登半島地震の地表変位の抽出

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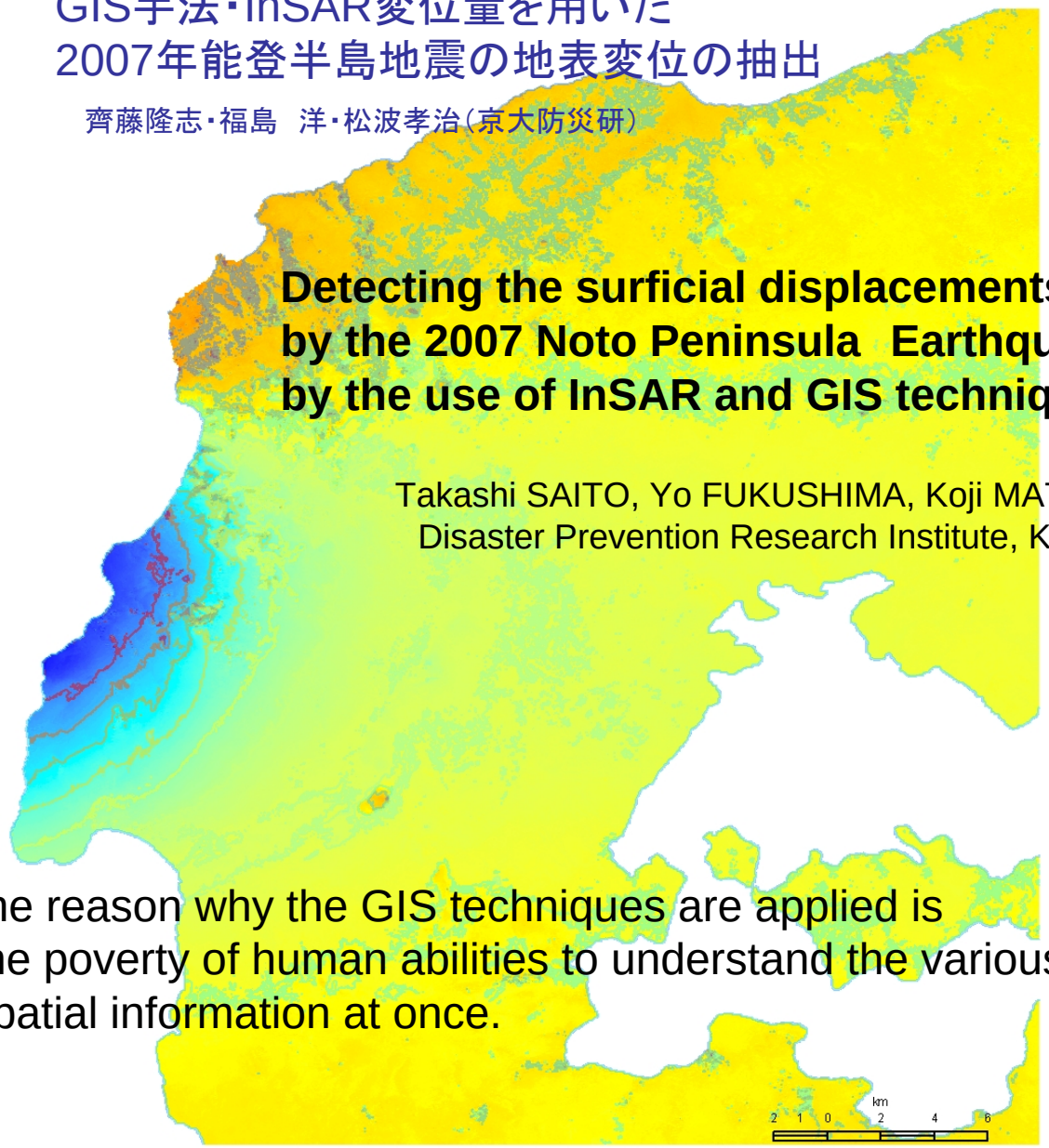

Detecting the surficial displacements triggered by the 2007 Noto Peninsula Earthquake by the use of InSAR and GIS techniques

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The reason why the GIS techniques are applied is the poverty of human abilities to understand the various spatial information at once.

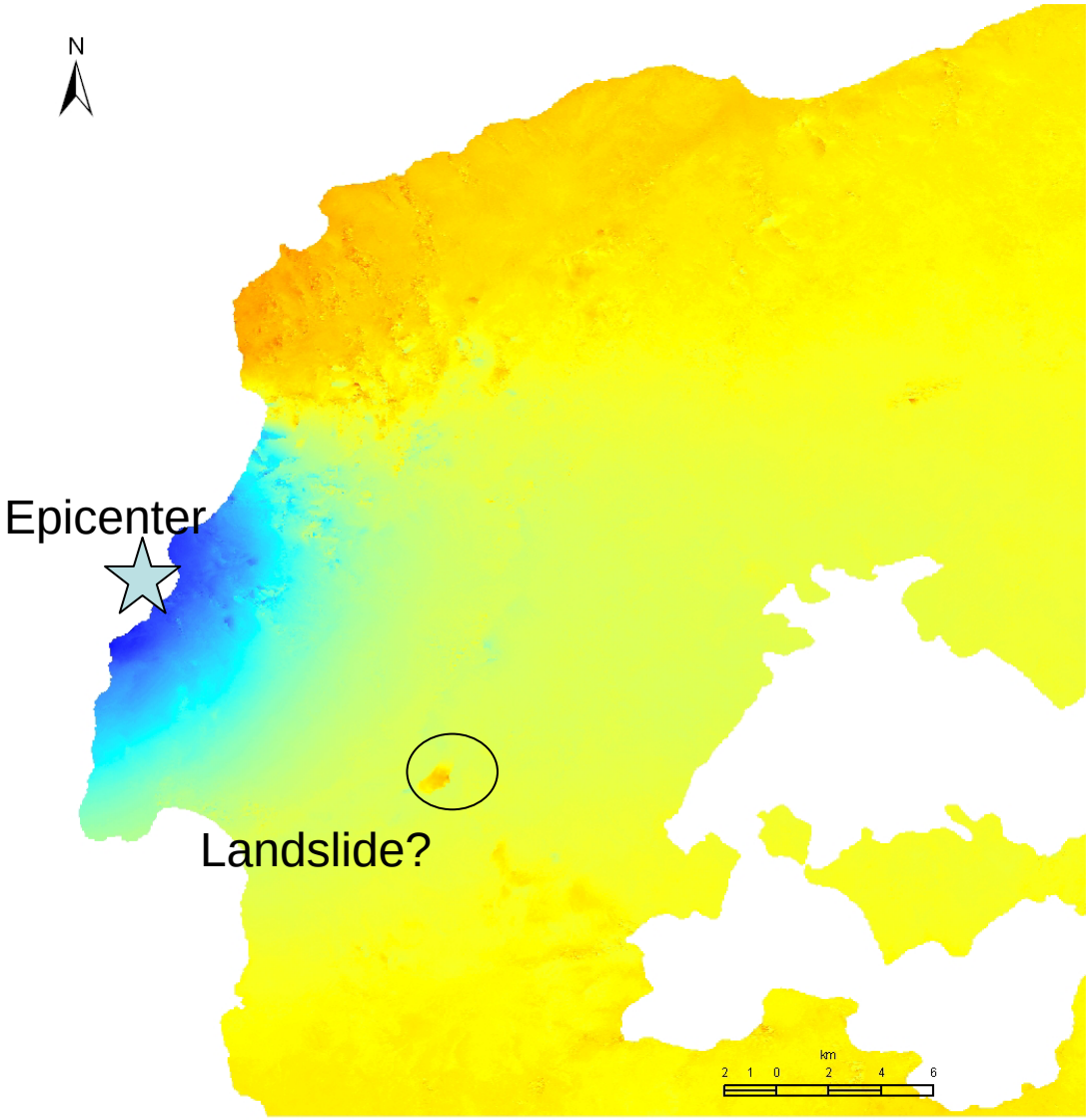
Introduction

The motivation / The initiation

- Fukushima *et al*., 2007 have suggested the existence of possible landslide in mountain area in Ishikawa Prefecture, triggered by The 2007 Noto Peninsula Earthquake of March 25, 2007 (Mw6.9)
- On the processes of field survey, on-site local surficial displacements (subsidences, liquifactions, landslides, and slope failures)

  had/could been detected by the results of InSAR analysis

Surficial displacement by the InSAR result (Fukushima et al.,2007)
originally shown in the fringe



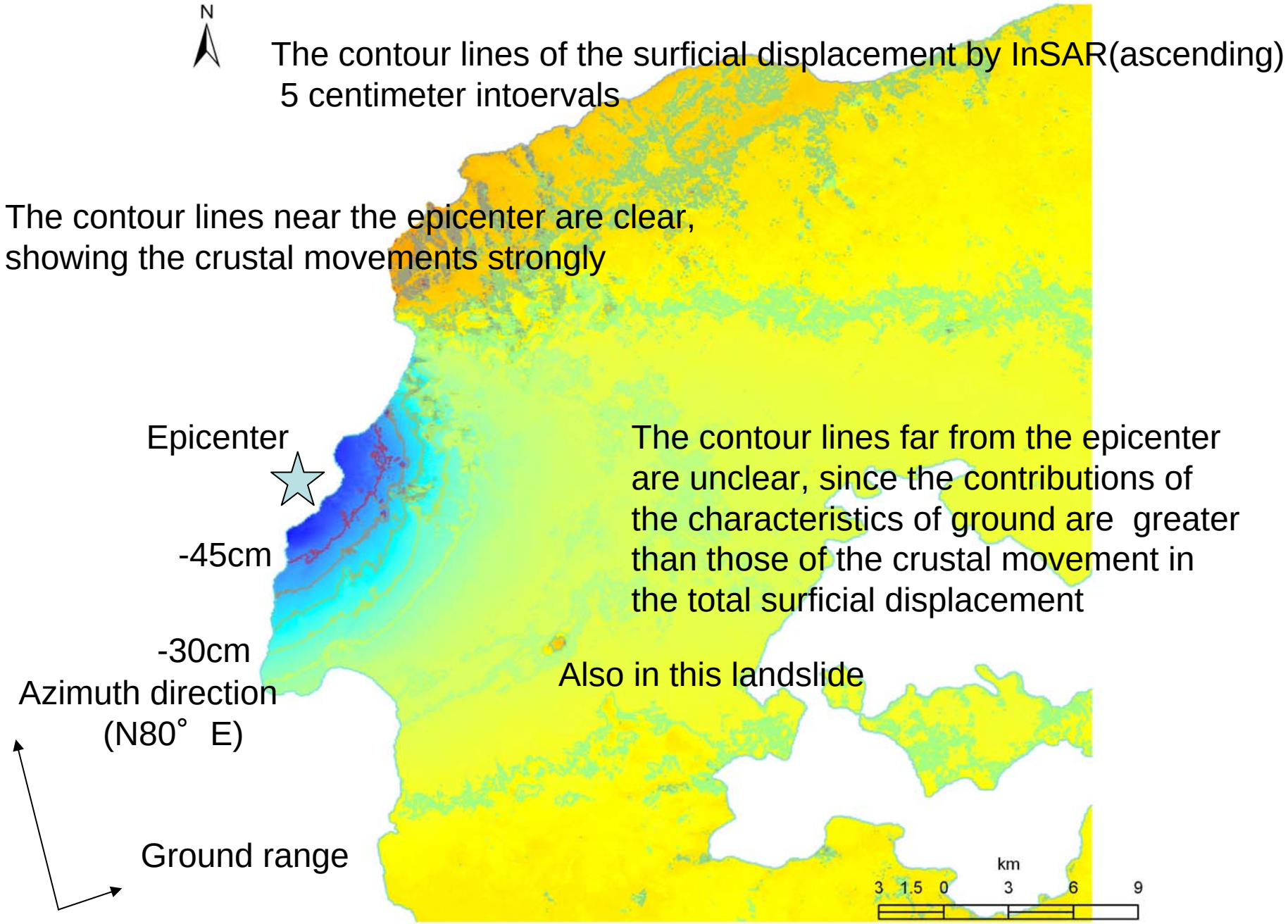
Satellite Daichi, PALSAR
Feb. 23, 2007-
Apr. 10, 2007
Ascending
Incident angle 47degree

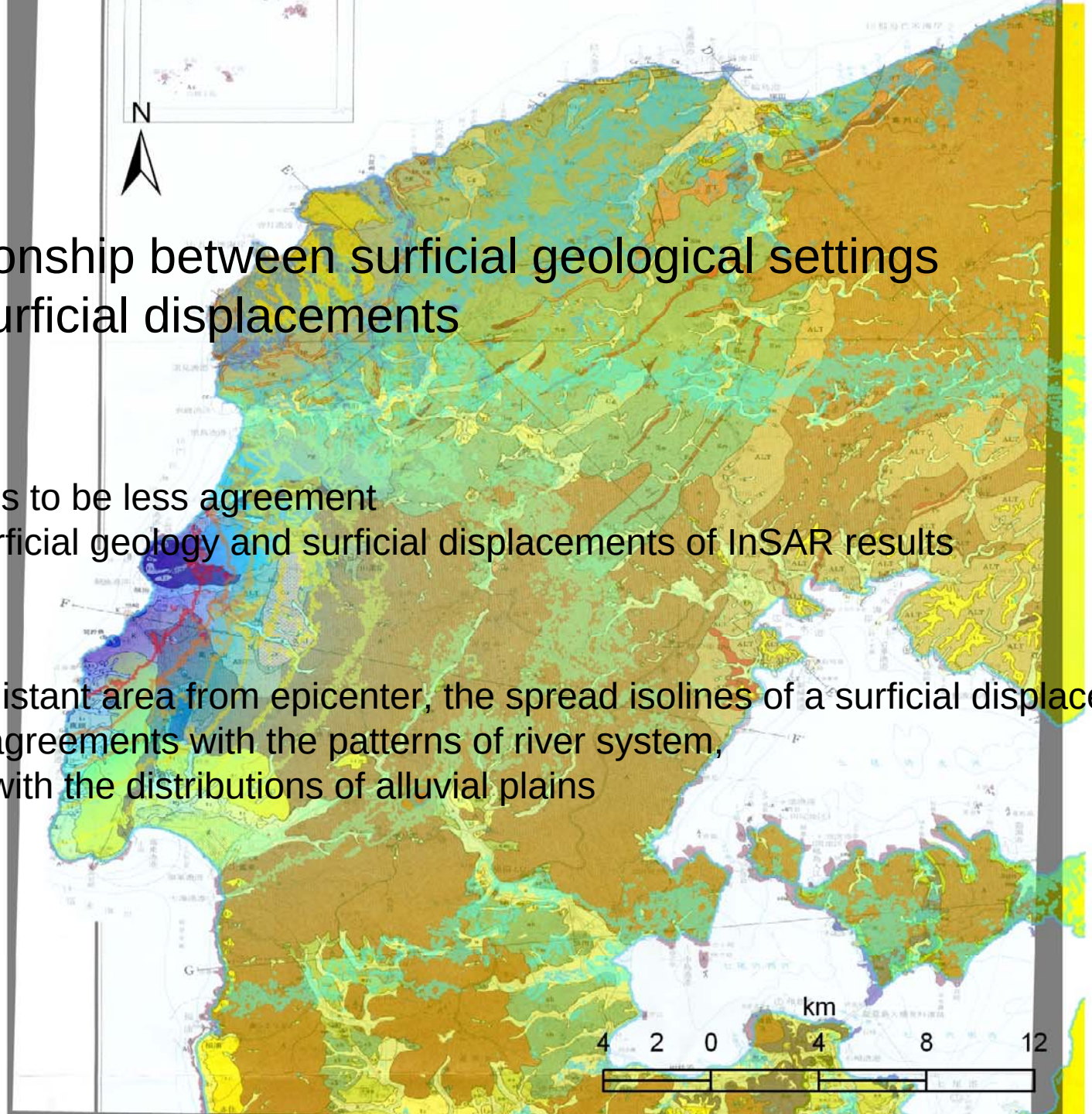
Azimuth direction
(N80° E)

Ground range

Methods

- Basically, the on-site recognitions of surficial displacements were conducted using the map of InSAR result (ground truth).
- GIS techniques are applied to analyze the geological, geomorphological, and hydrological back grounds of the positions of interest by overlaying the topographic maps, geological map, the aerial photographs, the landslide map database (NIED), the results of the geomorphological analysis with 10m-DEM

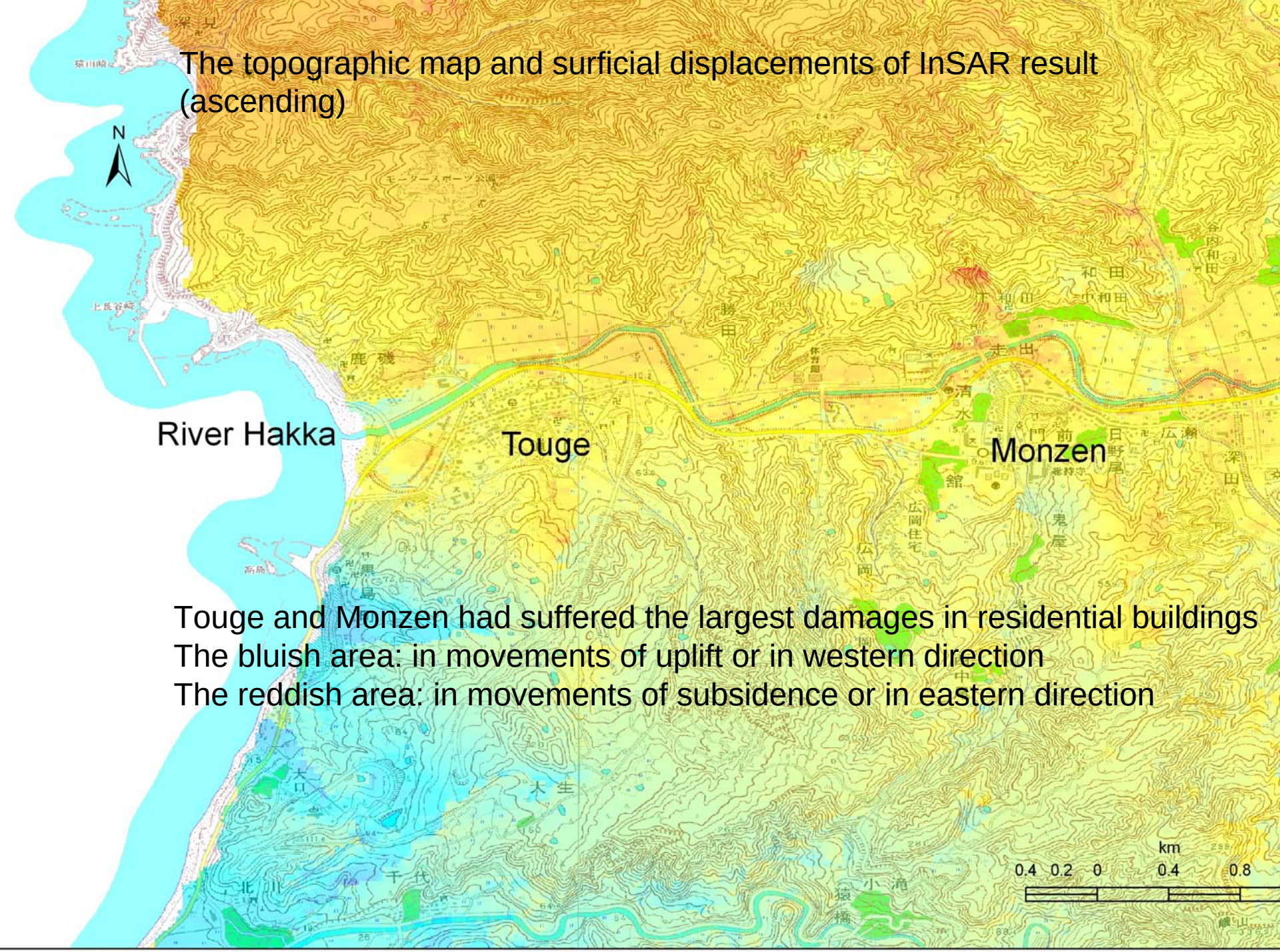

N
The contour lines of the surficial displacement by InSAR(ascending)
5 centimeter intoervals
The contour lines near the epicenter are clear,
showing the crustal movements strongly
Epicenter
-45cm
-30cm
Azimuth direction
(N80° E)
Ground range
The contour lines far from the epicenter
are unclear, since the contributions of
the characteristics of ground are greater
than those of the crustal movement in
the total surficial displacement
Also in this landslide
km
3 1.5 0 3 6 9

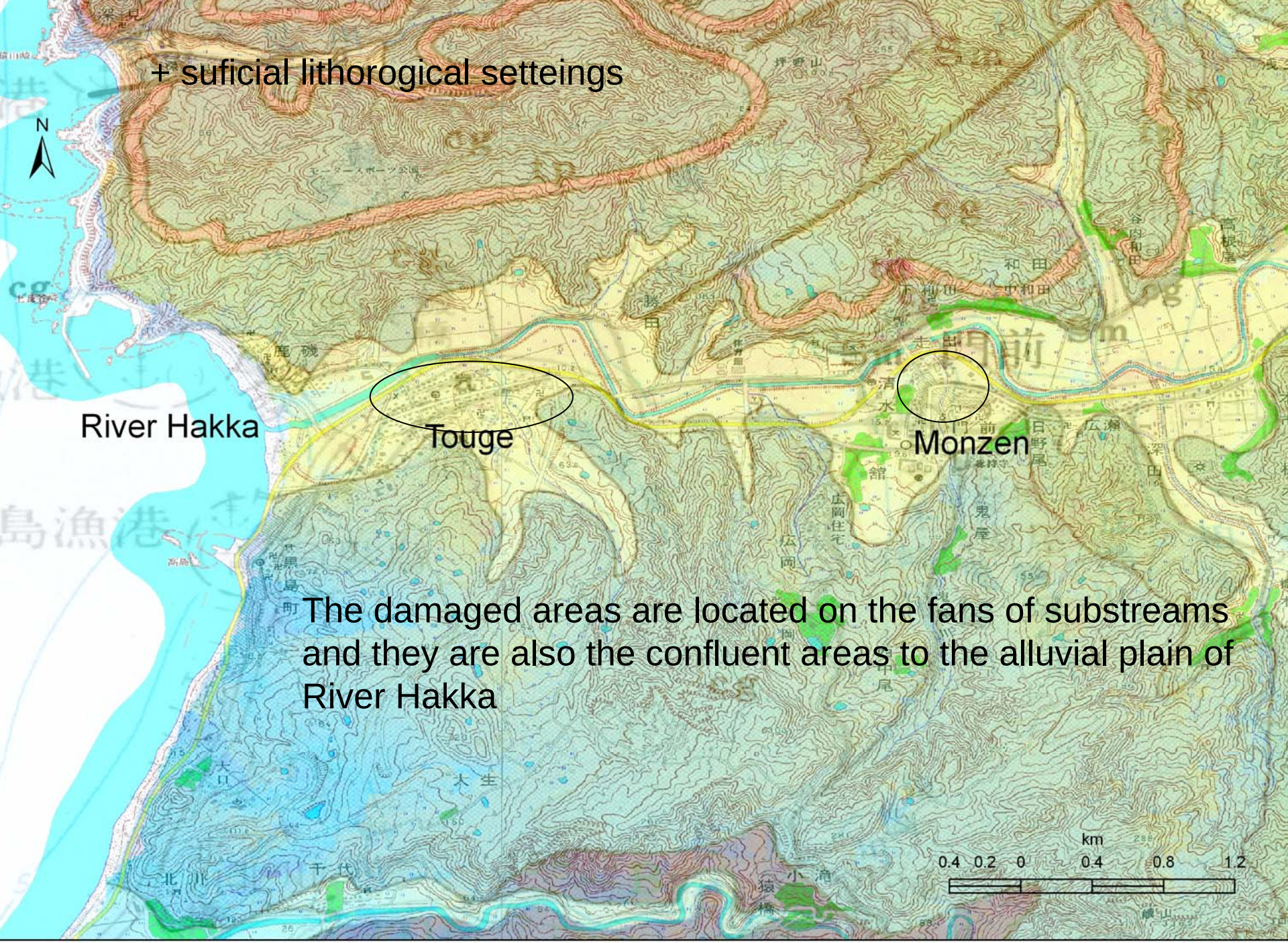


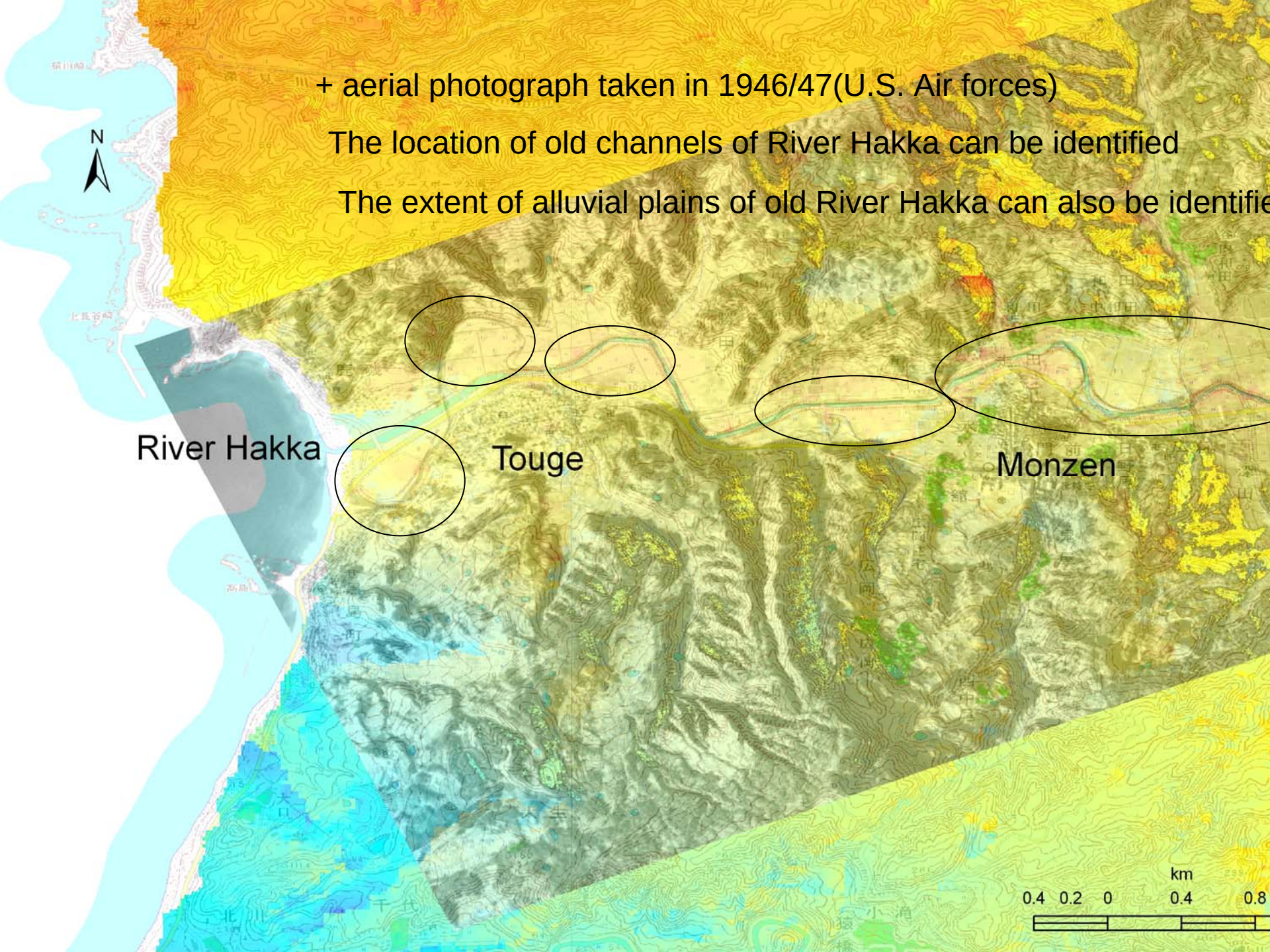
The relationship between surficial geological settings and the surficial displacements

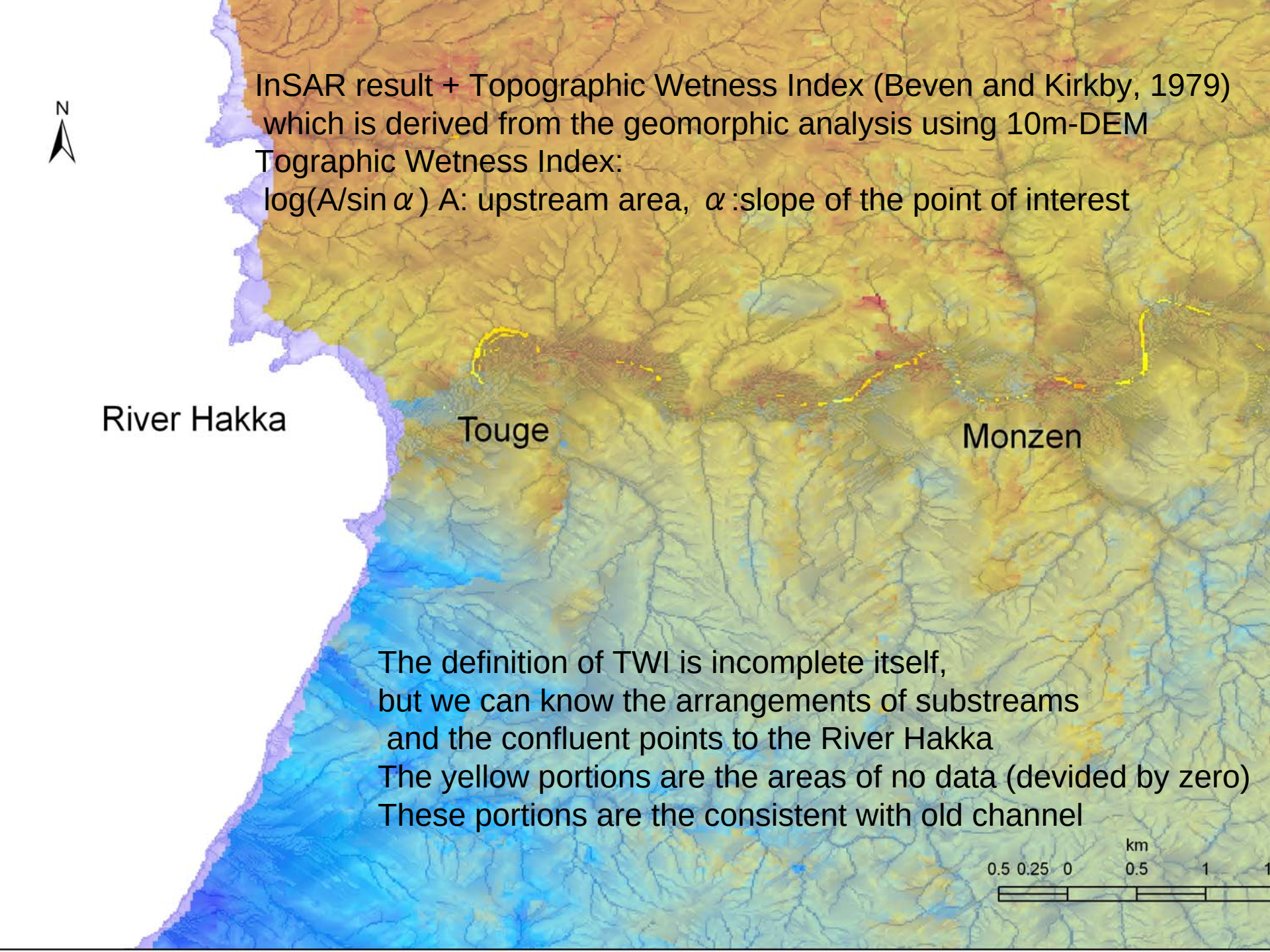
There seems to be less agreement
between surficial geology and surficial displacements of InSAR results

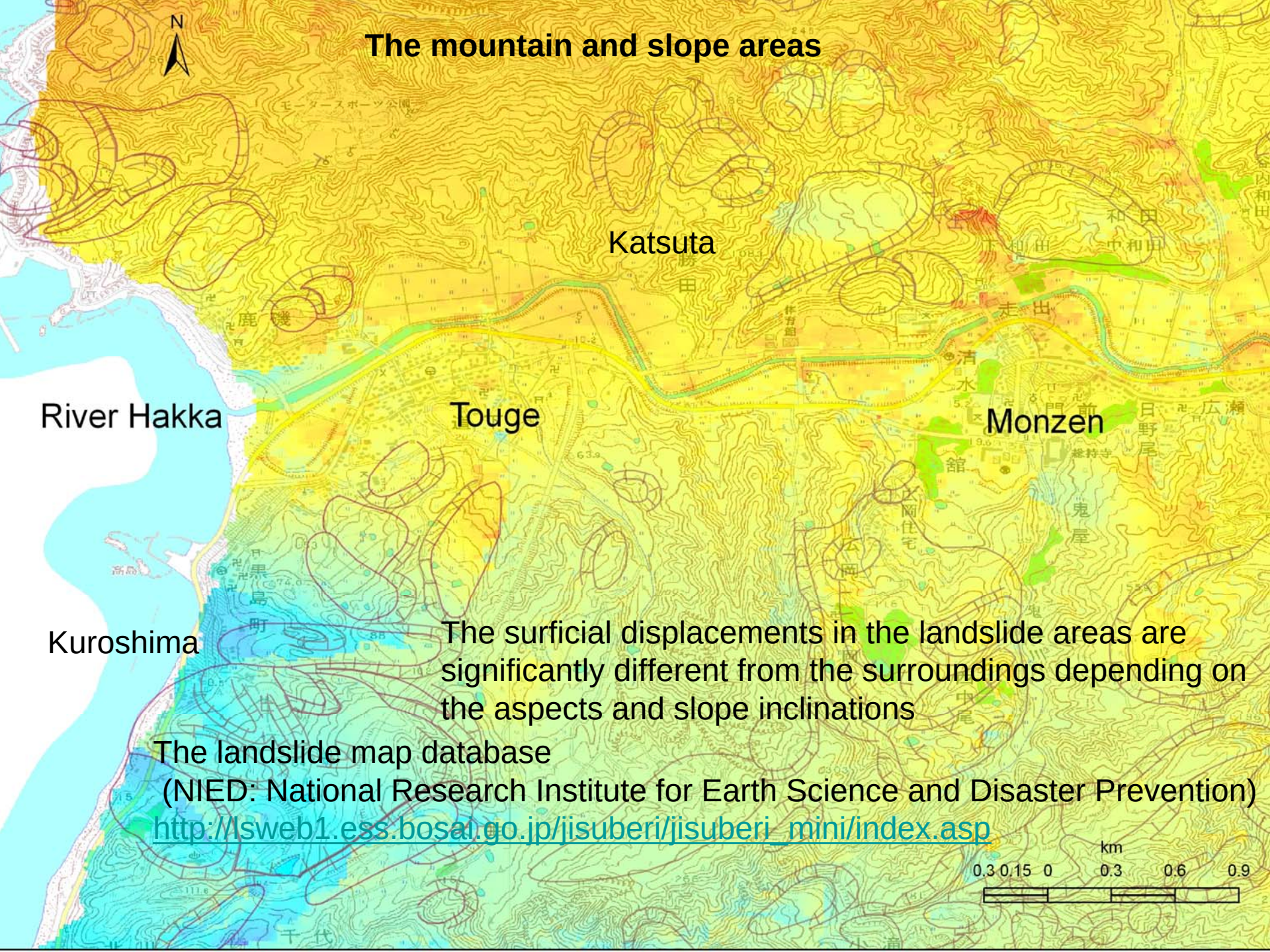
But in the distant area from epicenter, the spread isolines of a surficial displacement show the agreements with the patterns of river system, especially with the distributions of alluvial plains


The topographic map and surficial displacements of InSAR result (ascending)
N
River Hakka
Touge
Monzen
Touge and Monzen had suffered the largest damages in residential buildings
The bluish area: in movements of uplift or in western direction
The reddish area: in movements of subsidence or in eastern direction
km
0.4 0.2 0 0.4 0.8

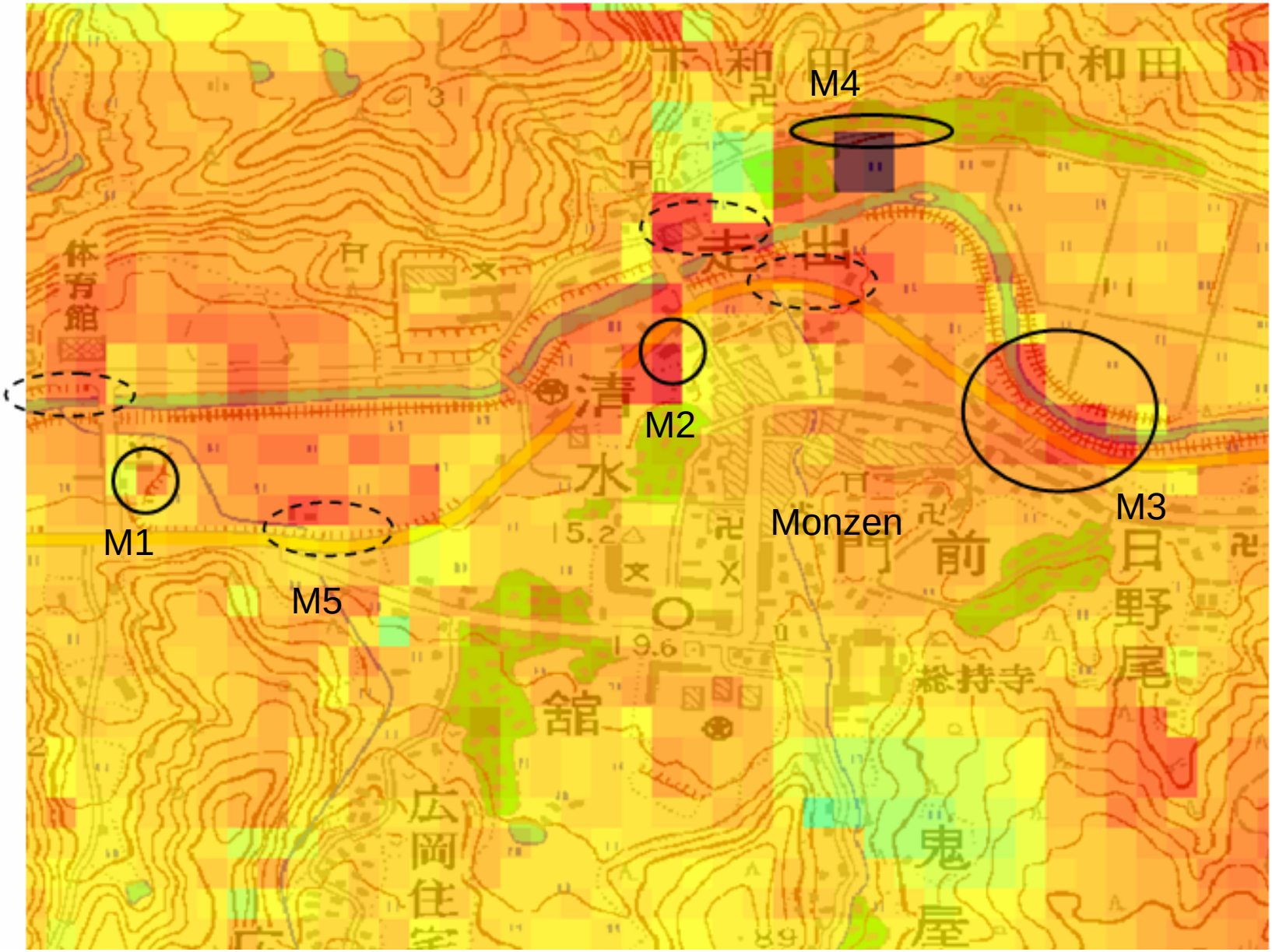

+ suficial lithorogical setteings
N
River Hakka
Touge
Monzen
The damaged areas are located on the fans of substreams and they are also the confluent areas to the alluvial plain of River Hakka
km
0.4 0.2 0 0.4 0.8 1.2


+ aerial photograph taken in 1946/47(U.S. Air forces)
The location of old channels of River Hakka can be identified
The extent of alluvial plains of old River Hakka can also be identifie
N
River Hakka
Touge
Monzen
km
0.4 0.2 0 0.4 0.8


N
InSAR result + Topographic Wetness Index (Beven and Kirkby, 1979)
which is derived from the geomorphic analysis using 10m-DEM
Tographic Wetness Index:
log(A/sin α) A: upstream area, α :slope of the point of interest
River Hakka
Touge
Monzen
The definition of TWI is incomplete itself,
but we can know the arrangements of substreams
and the confluent points to the River Hakka
The yellow portions are the areas of no data (devided by zero)
These portions are the consistent with old channel
km
0.5 0.25 0 0.5 1


The mountain and slope areas
N
Katsuta
River Hakka
Touge
Monzen
Kuroshima
The surficial displacements in the landslide areas are significantly different from the surroundings depending on the aspects and slope inclinations
The landslide map database
(NIED: National Research Institute for Earth Science and Disaster Prevention)
http://lsweb1.ess.bosai.go.jp/jisuberi/jisuberi_mini/index.asp
km
0.3 0.15 0 0.3 0.6 0.9

The examples of ground surface deformations around Monzen area

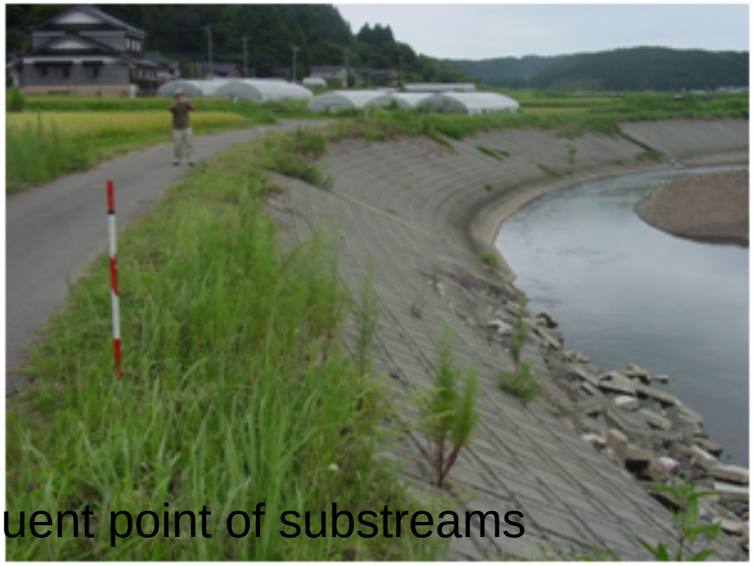


M1: The subsidence of ground surface at Monzen Bosai Center

M2: The examples of ground surface subsidence near Monzen area

M3: The failures of the banks of River Hakka

This area is the back lands of River Hakka and also the fans of substreams



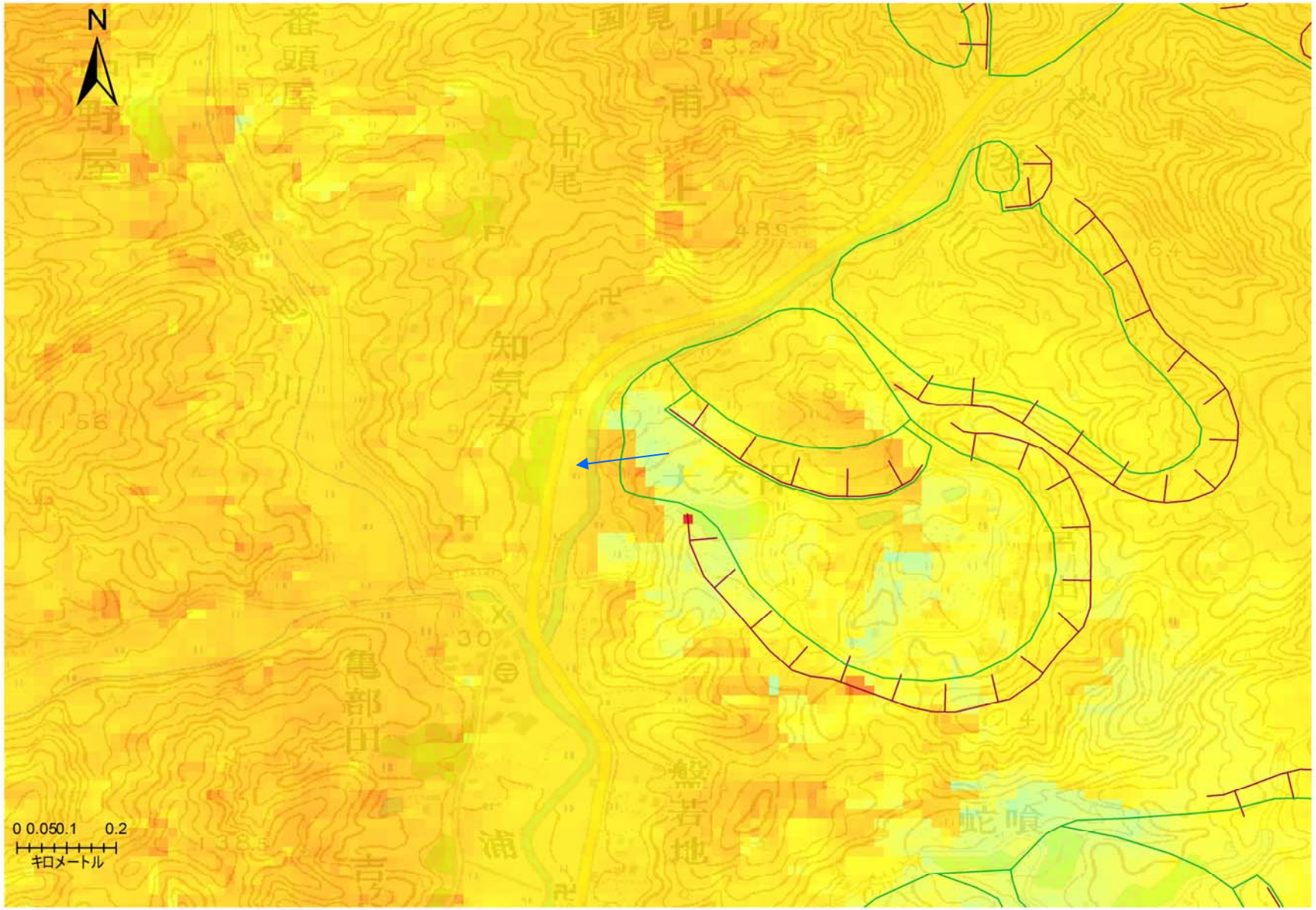
The failures of the bank walls near the confluent point of substreams

M4: The continuous cracks with ground surface subsidence

The examples of road surface deformations near M5

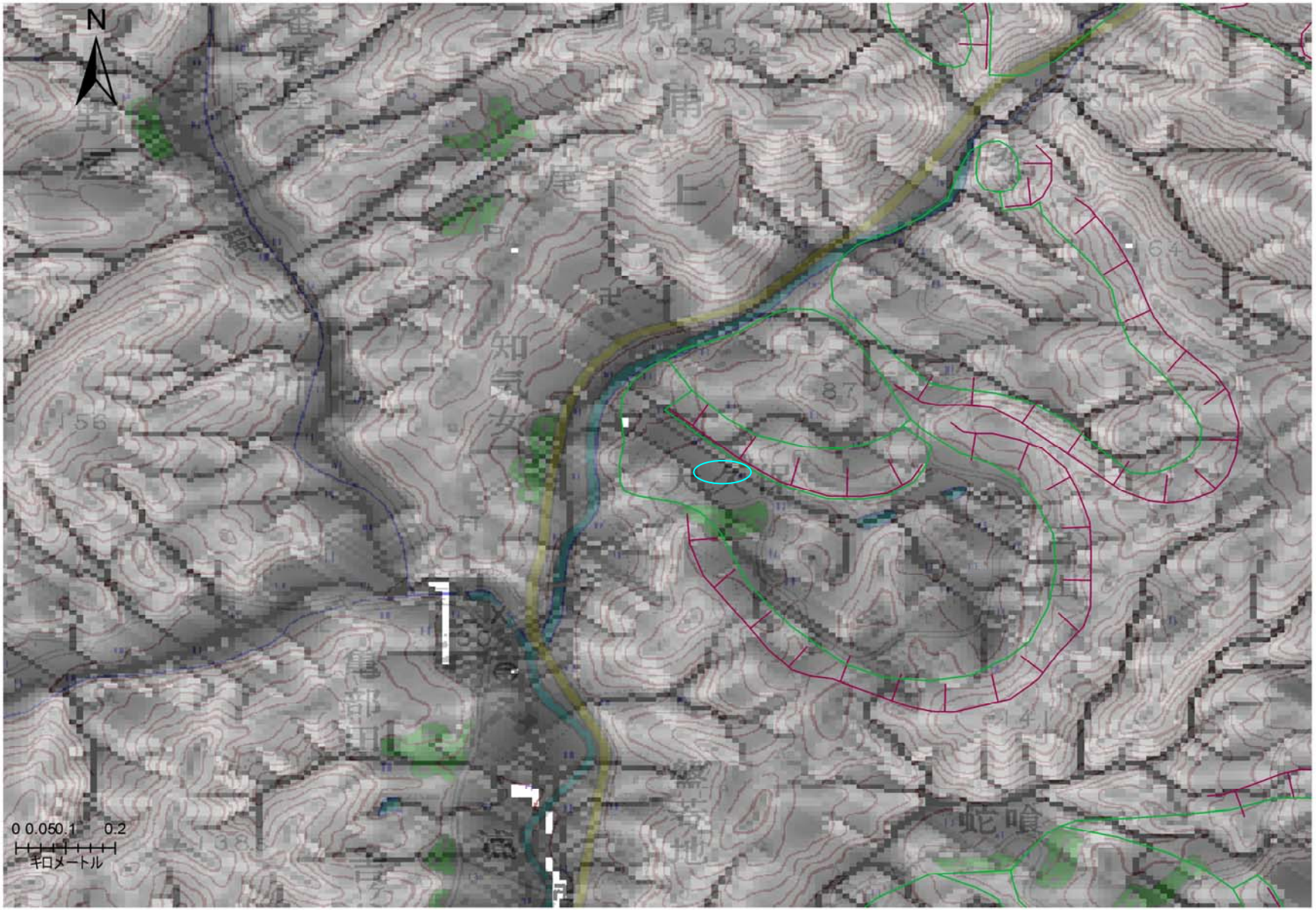
The back land of natural levee of River Hakka

The example of landslide in Ohkubo

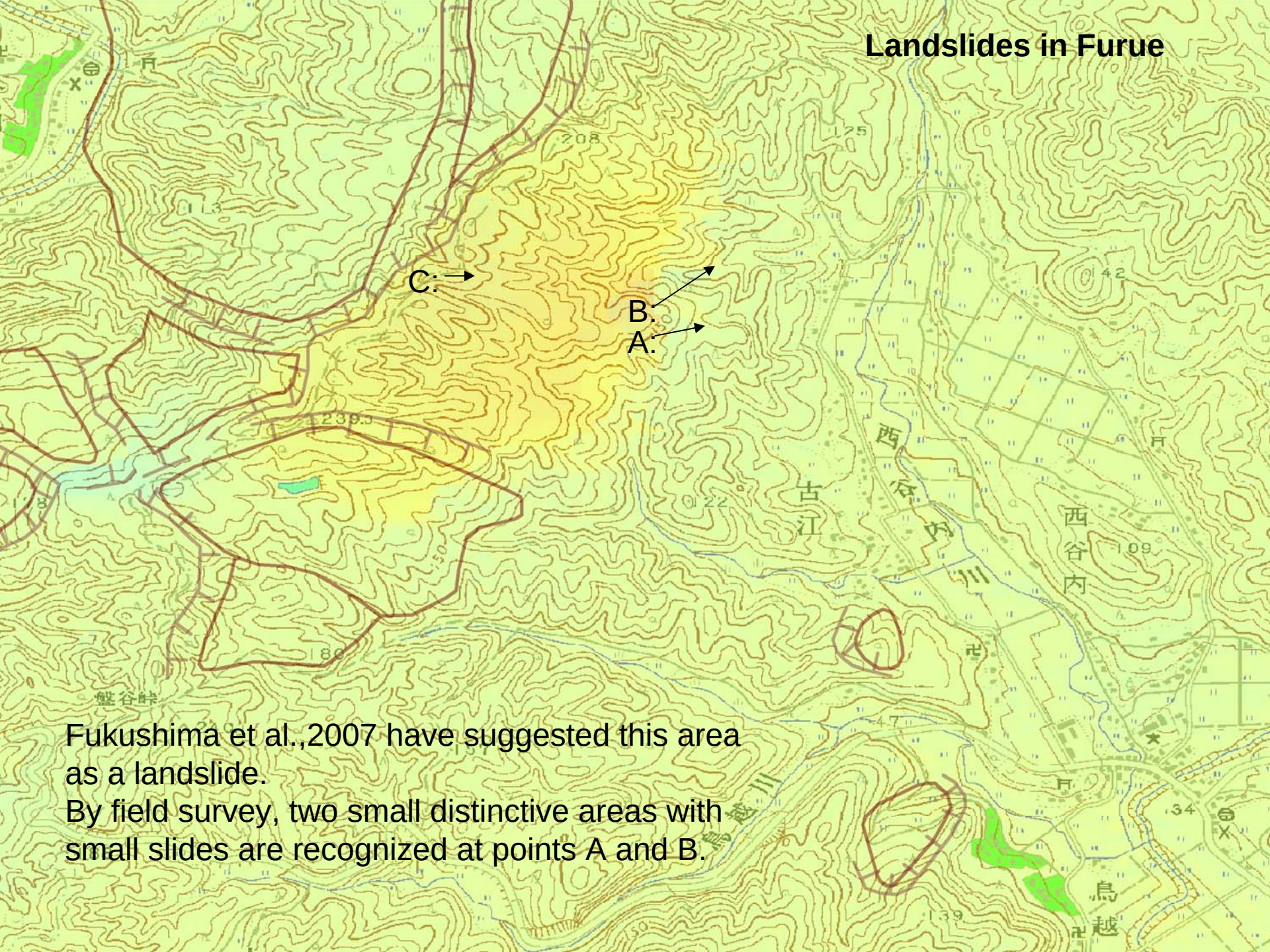


The groundwater seepage were observed from the walls.

TWI and areas of landslides



Landslides in Furue



Fukushima et al.,2007 have suggested this area as a landslide.
By field survey, two small distinctive areas with small slides are recognized at points A and B.

Point A

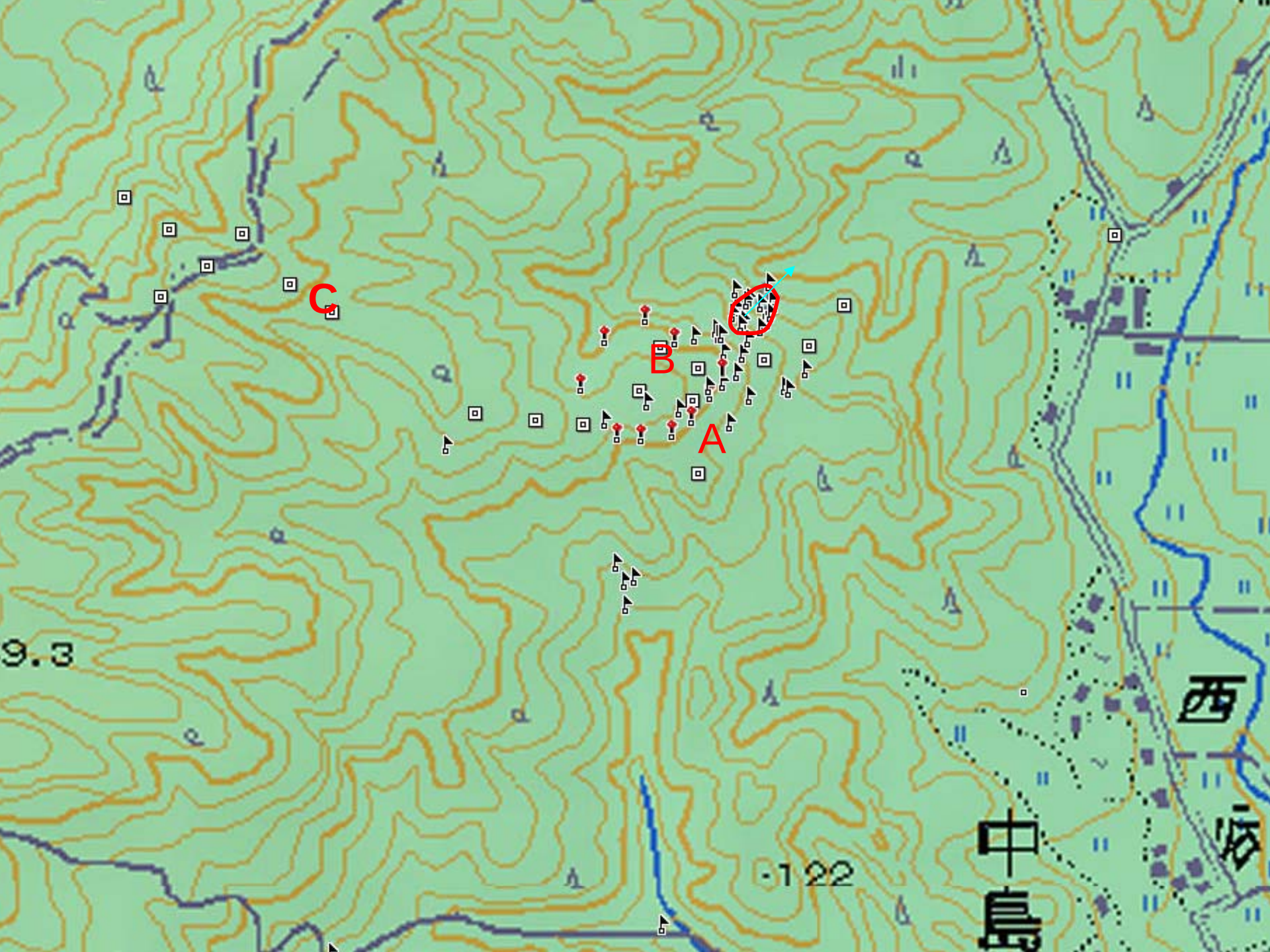
The direction of the surficial movement is almost to the east.

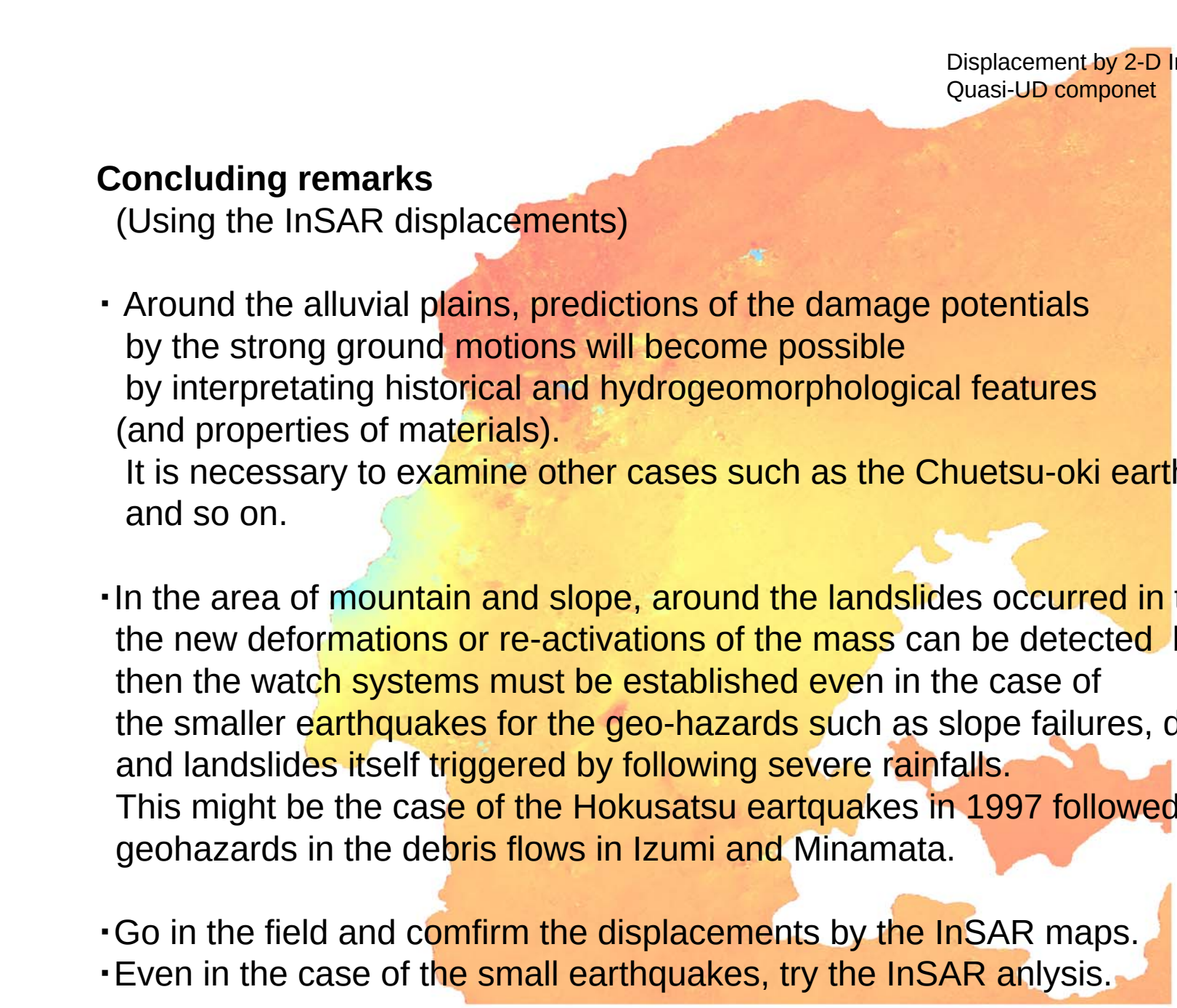
Ponit B

Point B
This slide could not be recognized in the result of InSAR of the ascending (Azimuth direction is N80° E)

The light-blue arrow shows the direction of the slide. The direction is almost in north-east.
The line shows the top of the scur.

In the result of InSAR of the descending (Azimuth direction is S10° W), this slide could be recognized as surficial displacements.


C
B
A
9.3
-122
中
島
西



Concluding remarks
(Using the InSAR displacements)

・Around the alluvial plains, predictions of the damage potentials by the strong ground motions will become possible by interpretating historical and hydrogeomorphological features (and properties of materials).
It is necessary to examine other cases such as the Chuetsu-oki earthquake, and so on.

・In the area of mountain and slope, around the landslides occurred in the past, the new deformations or re-activations of the mass can be detected by InSAR, then the watch systems must be established even in the case of the smaller earthquakes for the geo-hazards such as slope failures, debris flows and landslides itself triggered by following severe rainfalls.
This might be the case of the Hokusatsu eartquakes in 1997 followed by the geohazards in the debris flows in Izumi and Minamata.

・Go in the field and comfirm the displacements by the InSAR maps.
・Even in the case of the small earthquakes, try the InSAR anlysis.