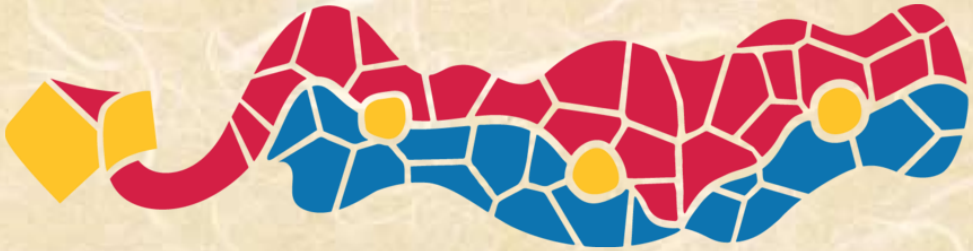
Introduction of flood evacuation route search using QGIS, PostGIS, GRASS and pgRouting



Yoichi Kayama

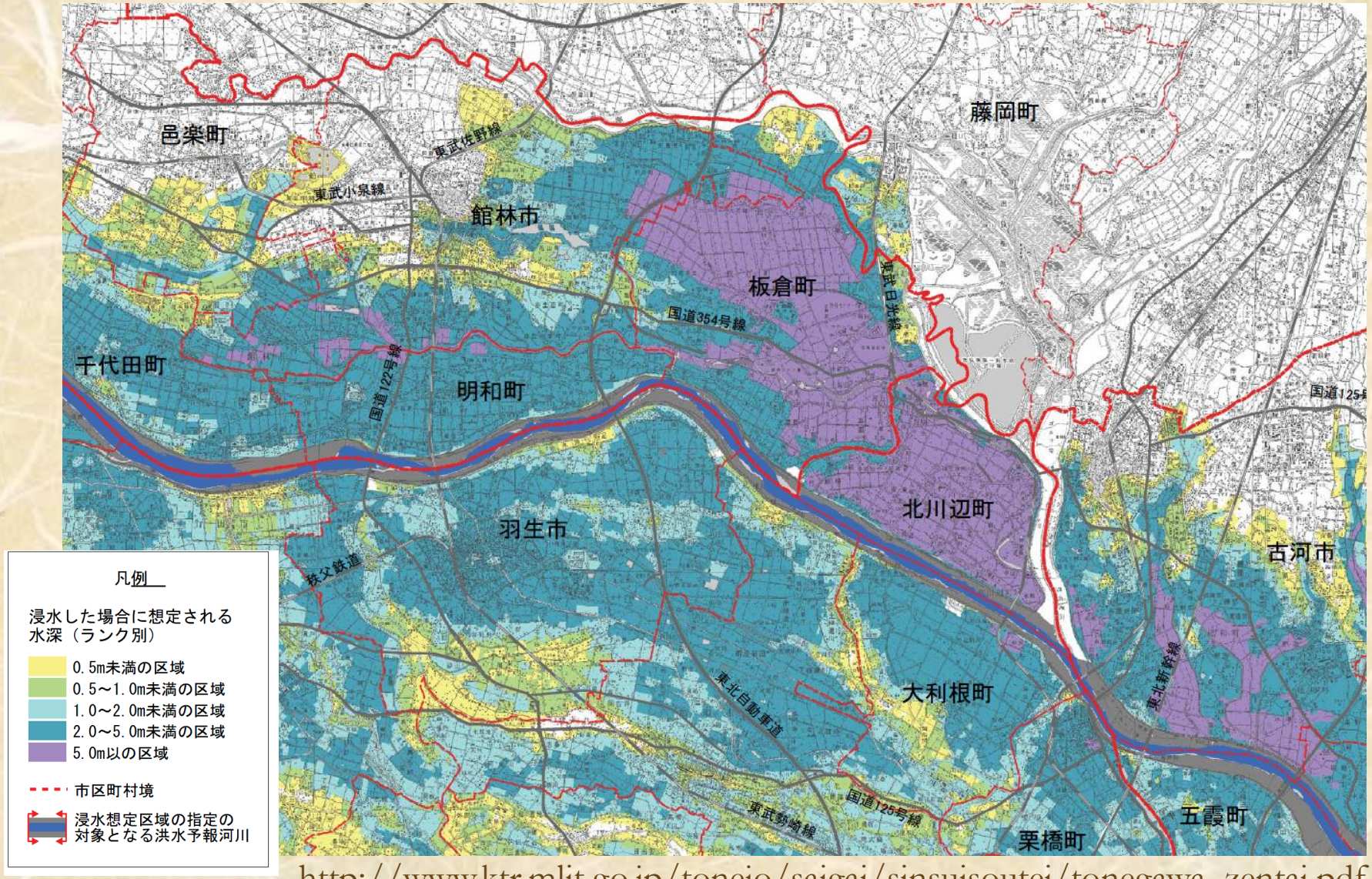
Self-introduction

- A member of OSGeo.JP
- A member of GISA Japan(also a member of FOSS4G SIG)
- Coordinator of QGIS Japanese GUI translators
- Working as GIS programmer and researcher at Aero Asahi Corporation

Flood area simulation map

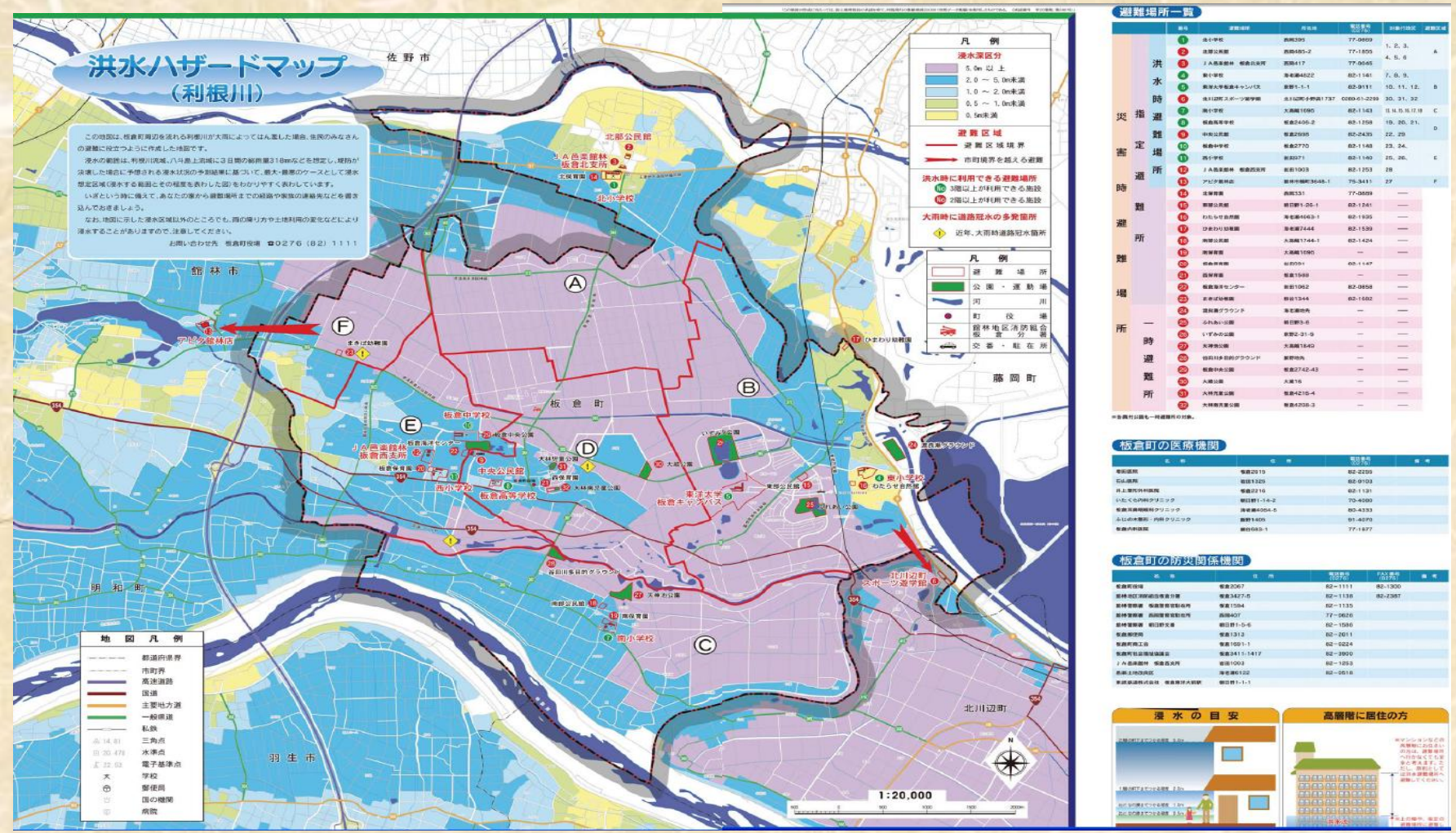
- In Japan, since 2001 , MLIT(The Ministry of Land, Infrastructure, Transport and Tourism) and prefectural governments made maps of flood area simulation about major rivers.

Flood area simulation map



http://www.ktr.mlit.go.jp/tonejo/saigai/sinsuisoutei/tonegawa_zentai.pdf

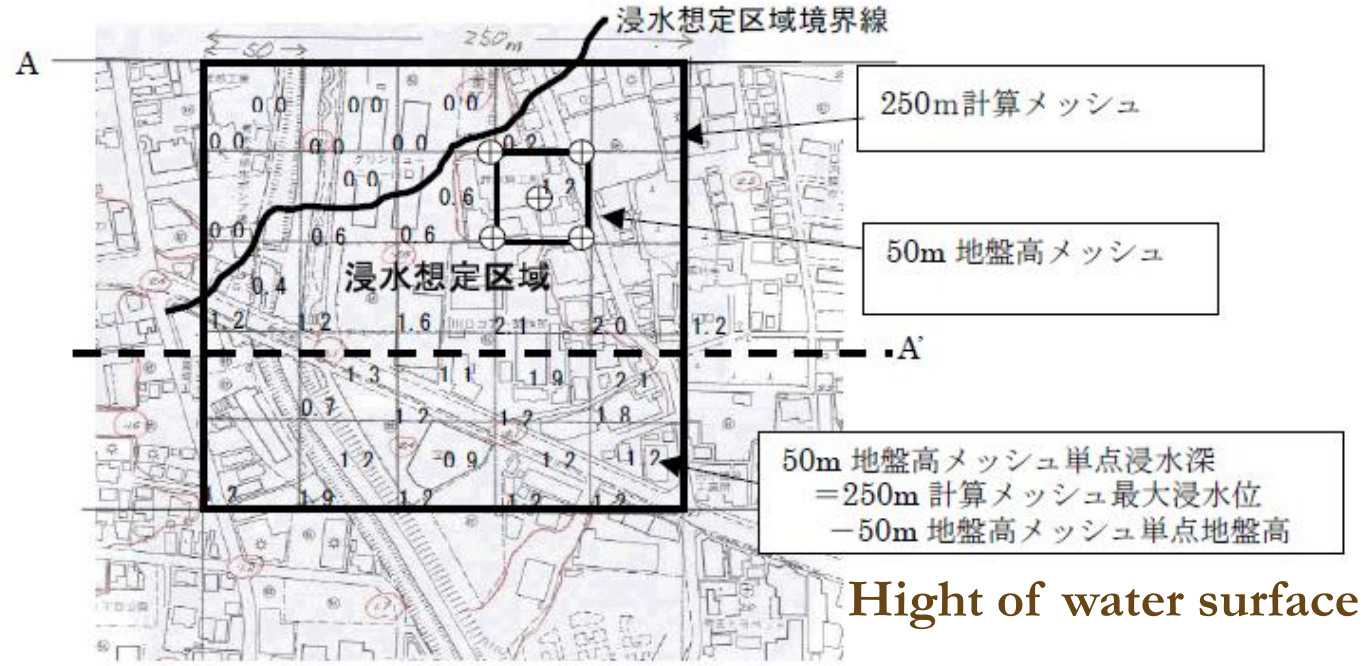
Hazard map (made by local government)



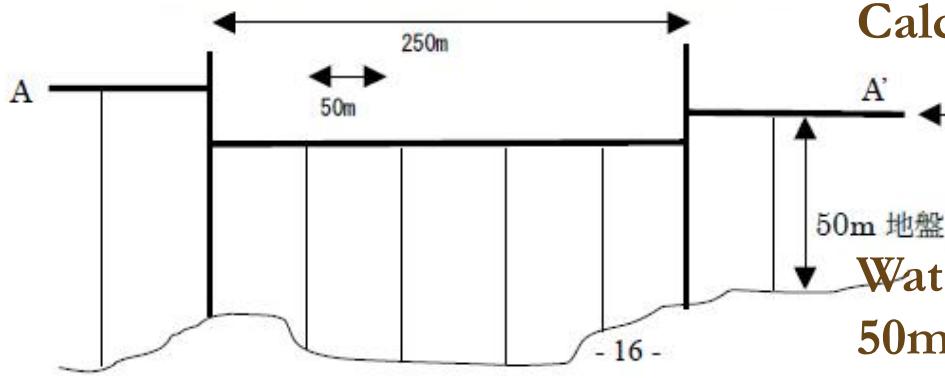
http://www.town.itakura.gunma.jp/kurashi/kinkyuu/hazard.html

Water depth calculated unit

making flood area simulation maps



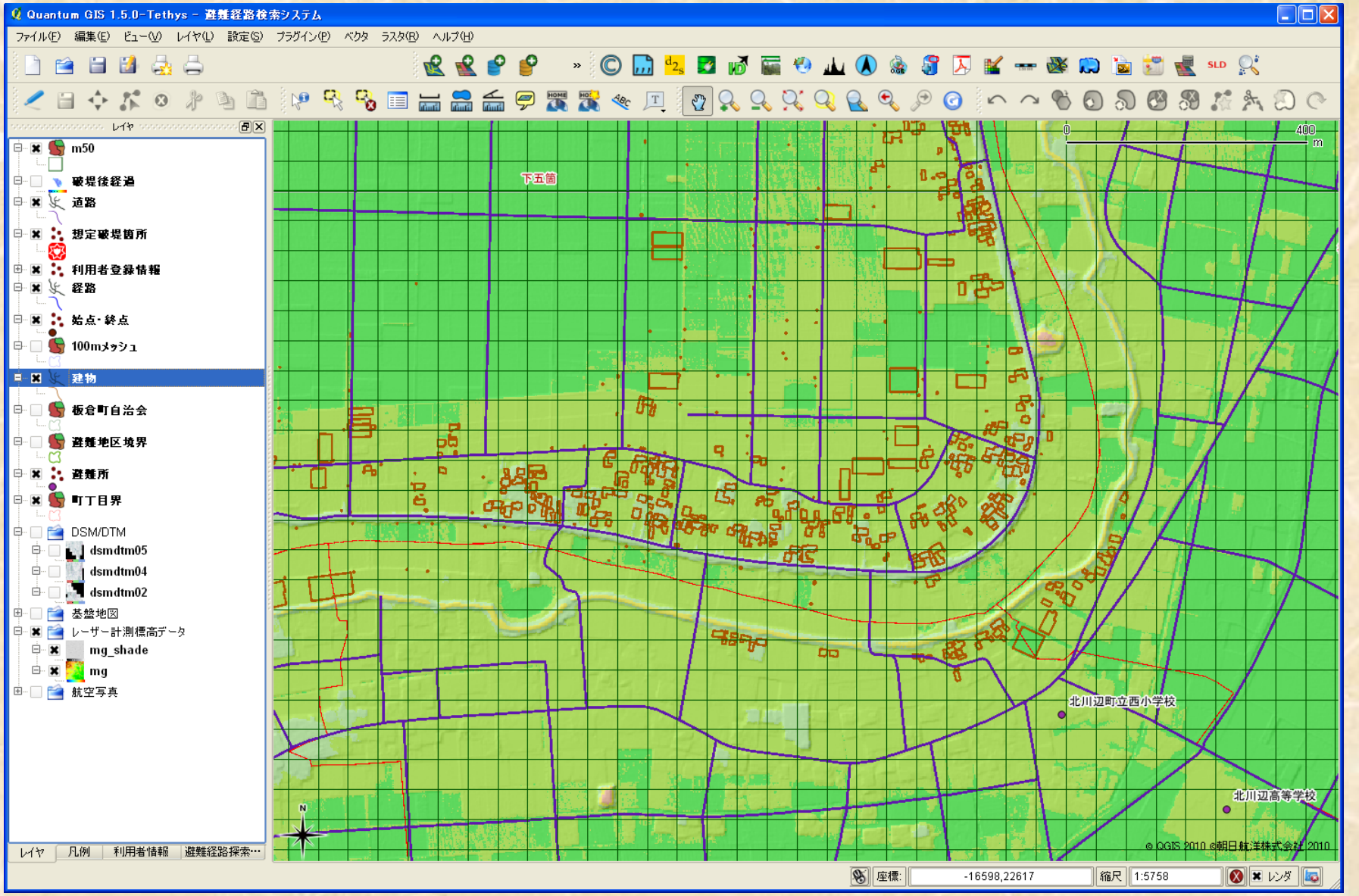
Hight of water surface were Calculated by 250m grid unit



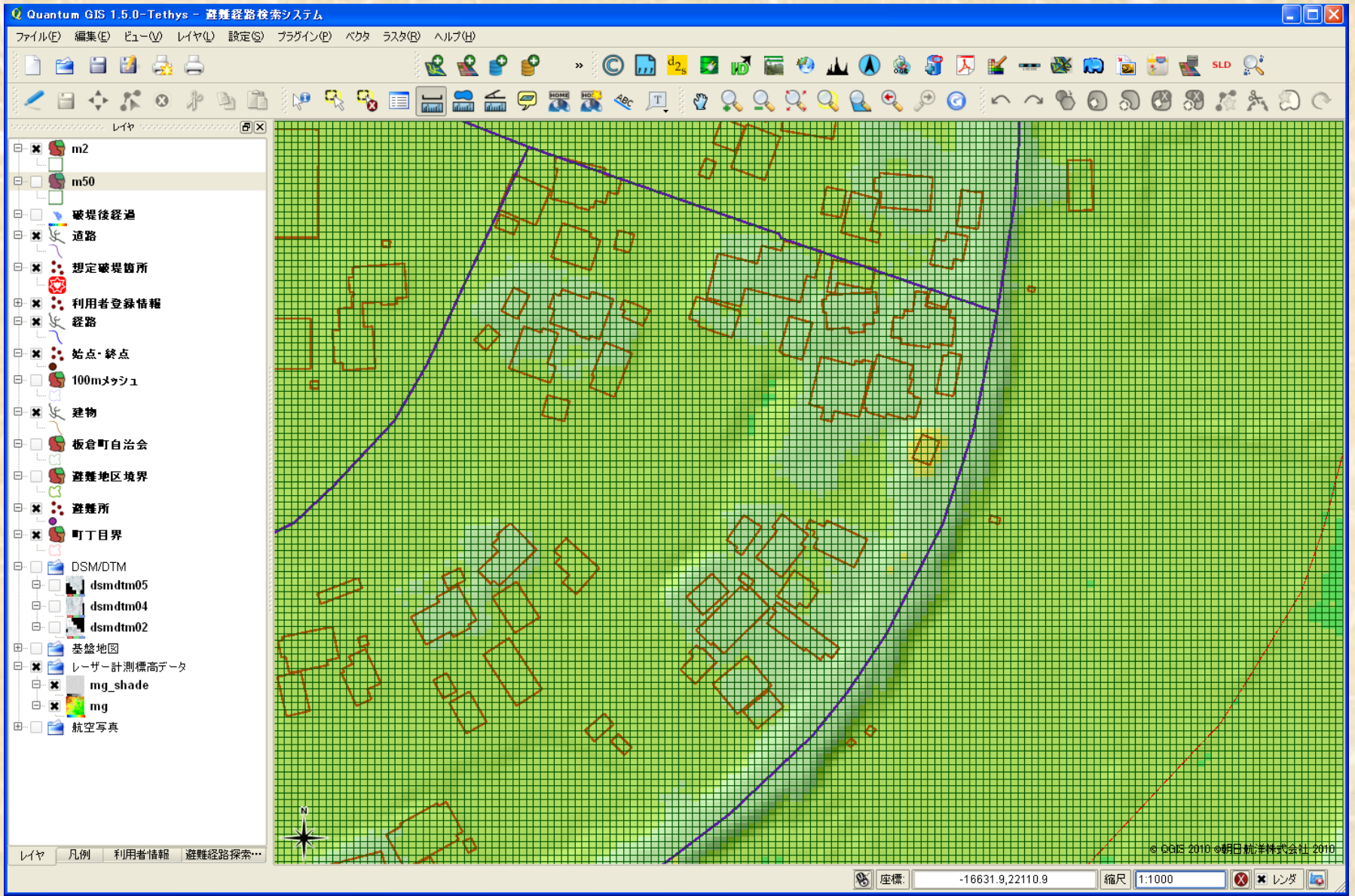
Water depths were calculated by 50m grid unit of ground elevation

http://www.mlit.go.jp/river/shishin_guideline/bousai/press/200507_12/050705/050705_manual.pdf

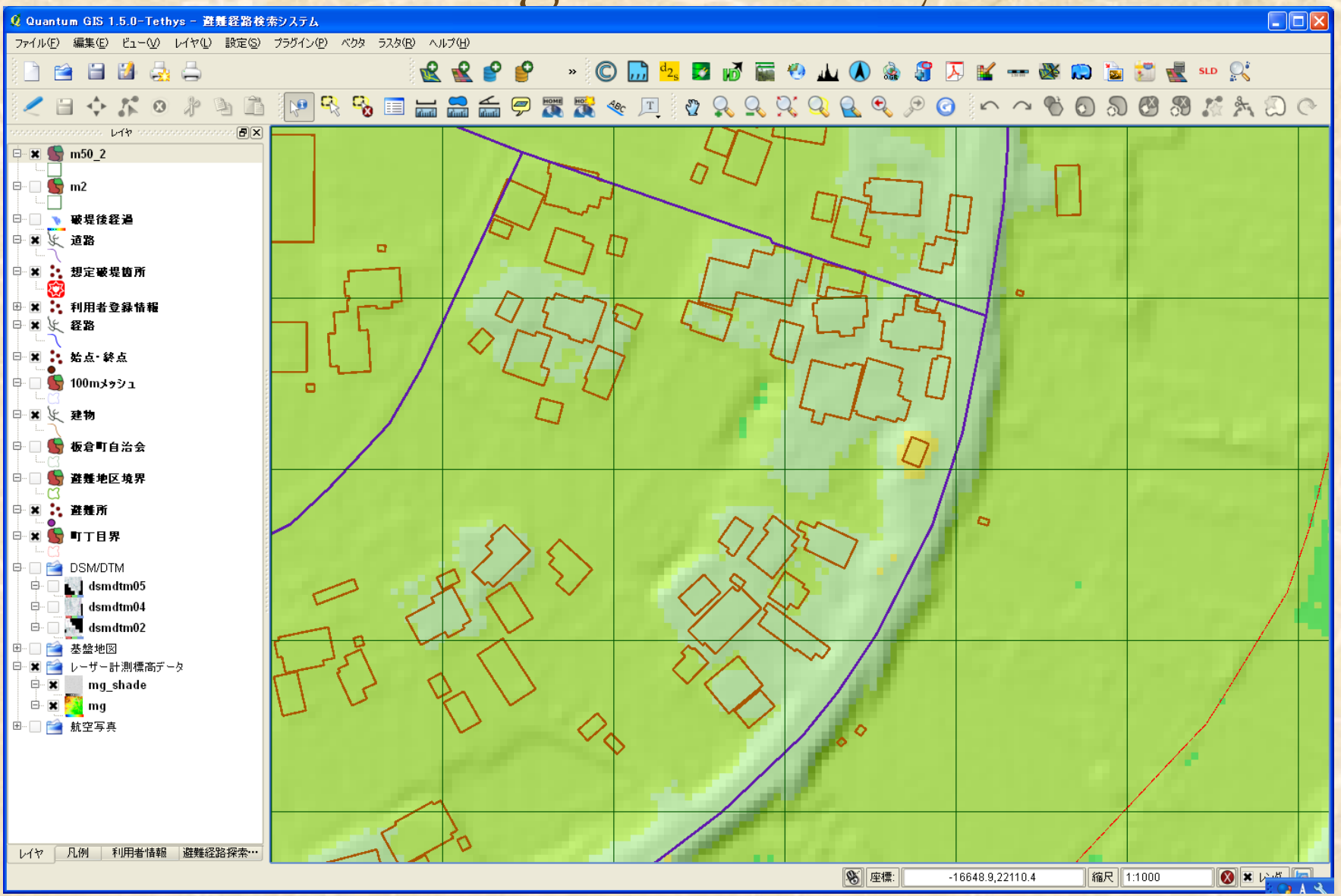
50m grid overlay



2m grid overlay

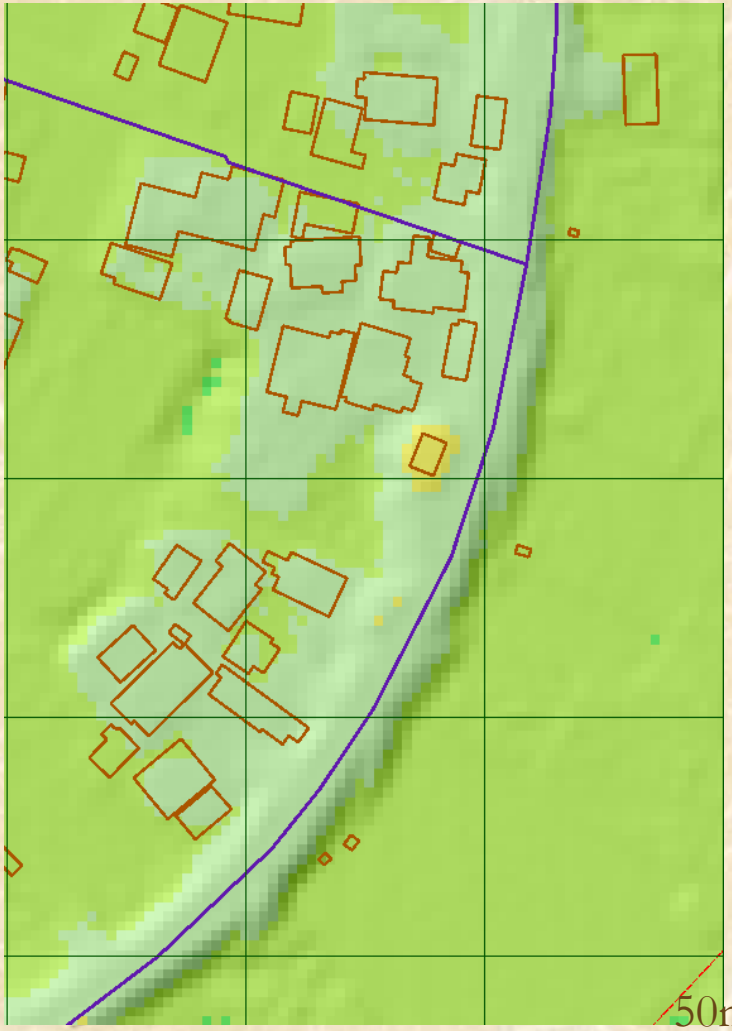


50m grid overlay



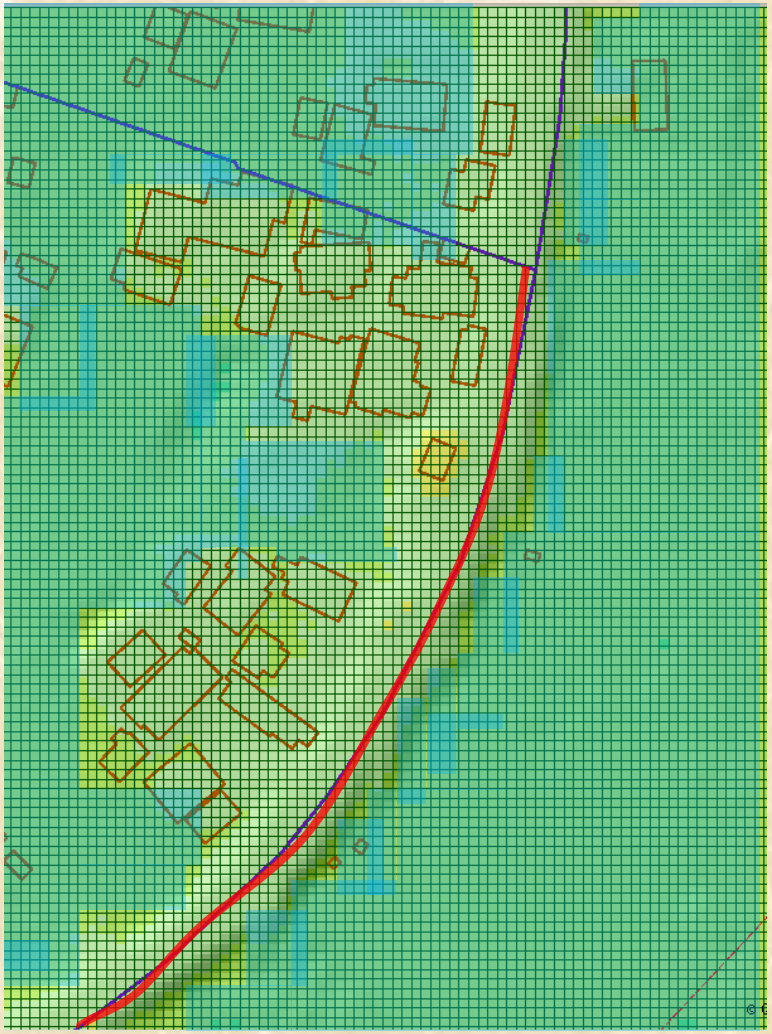
Compare 2m grid and 50m grid

2m

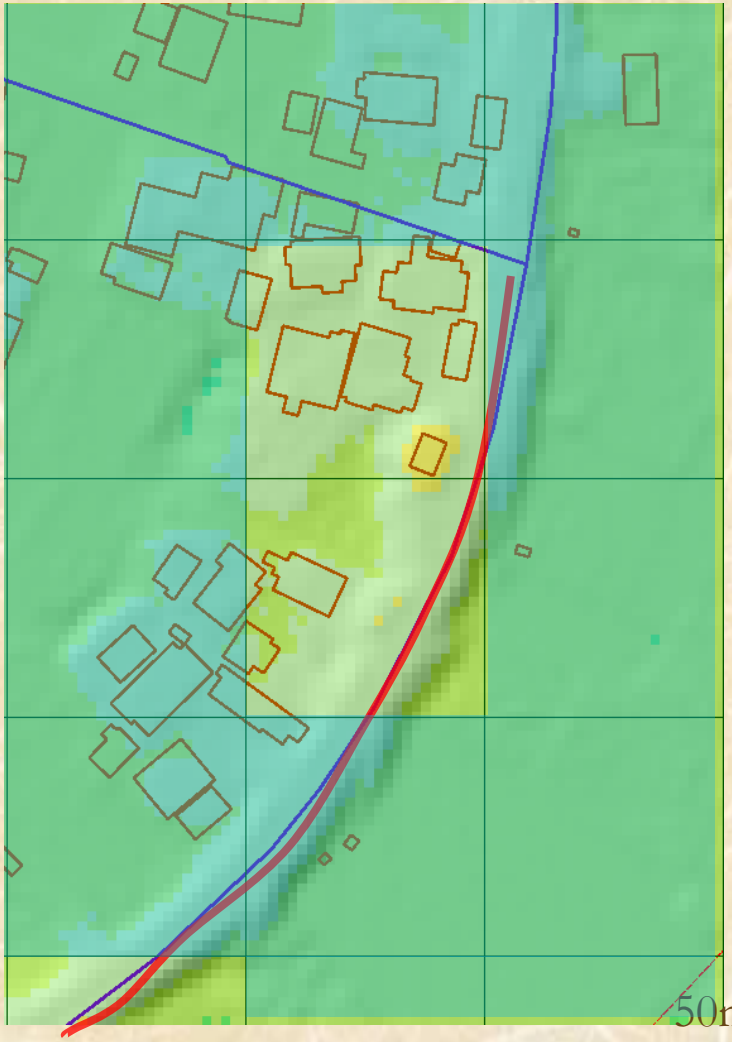


50m

using 2m grid ,we could find that such a road on bank is submerged or not



2m

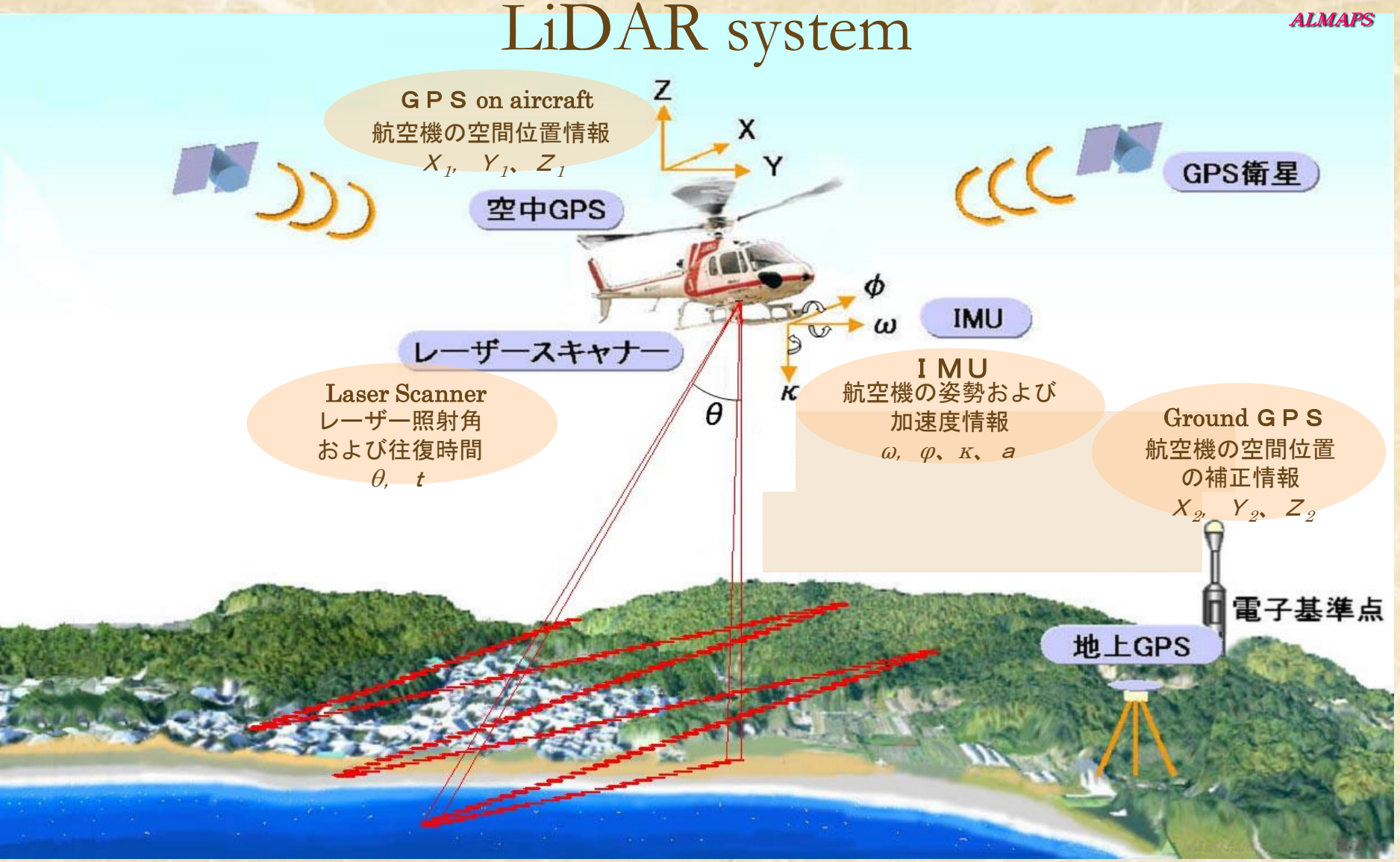


50m

Using fine grid is better

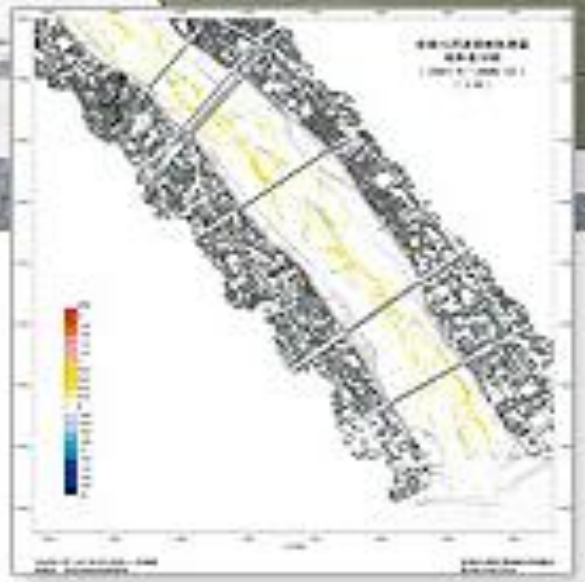
How can we get such a fine grid elevation data ?

We can get fine grid elevation data using LiDAR system



LiDAR System

ALMAPS(Asahi Laser MAPping System/Aerial Lidar Mapping)

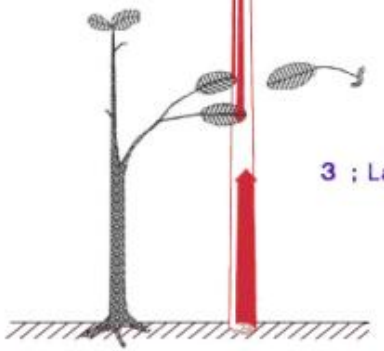


計測事例
（河川水位動向）

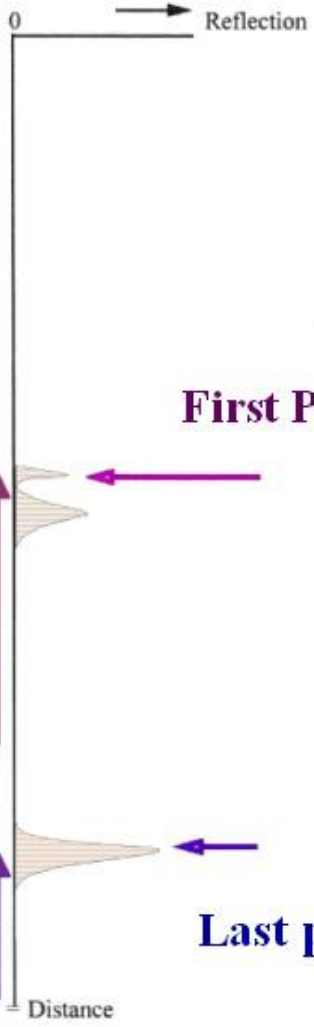
Types of pulse mode

One Shot

Near Infrared Rays Beam

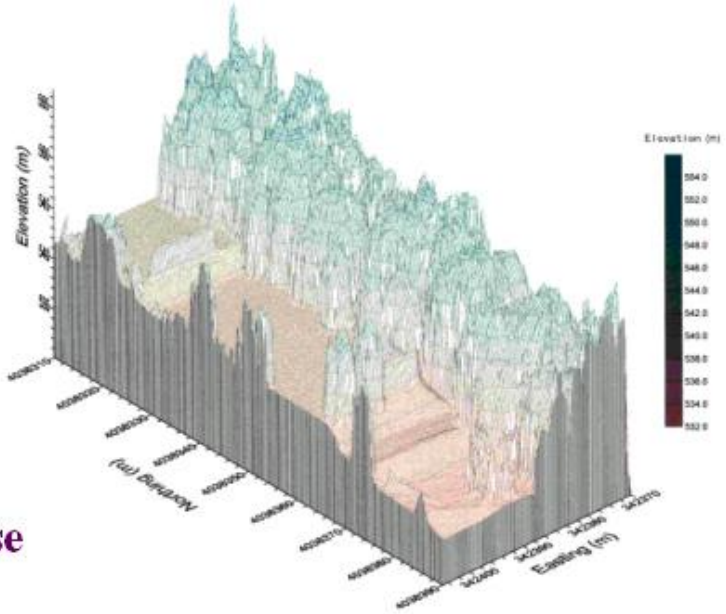


Receiving mode of pulse



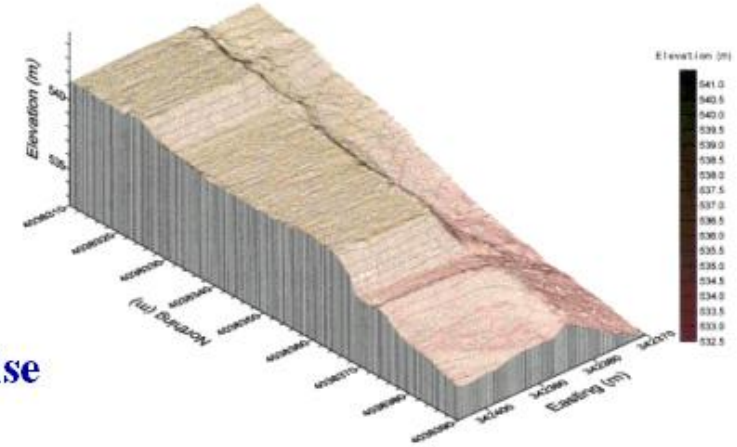
Distance(time) between receiving pulses

First Pulse



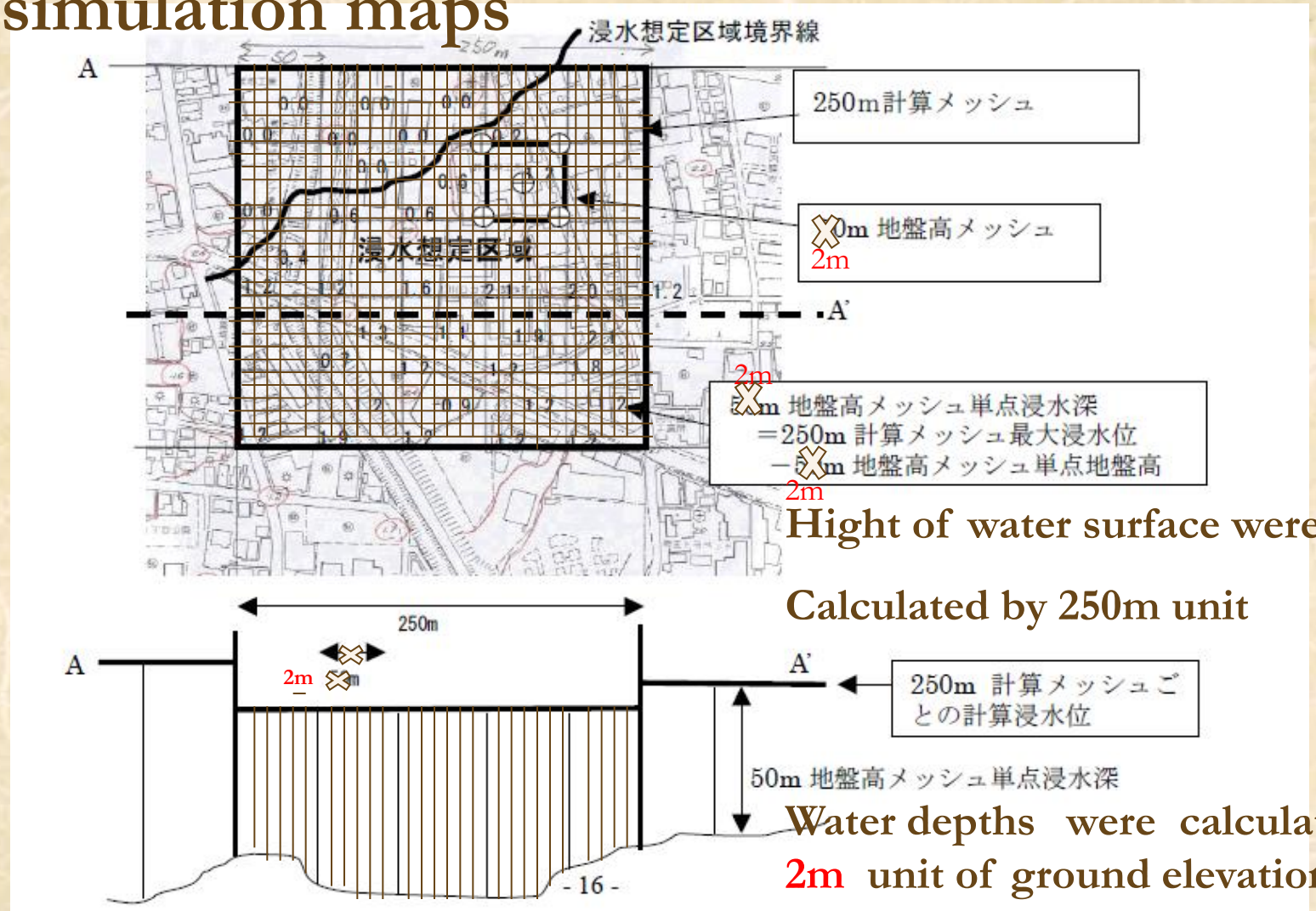
DSM ; Digital Surface Model (First Pulse Mode)

Last pulse



DTM ; Digital Terrain Model (Last Pulse Mode)

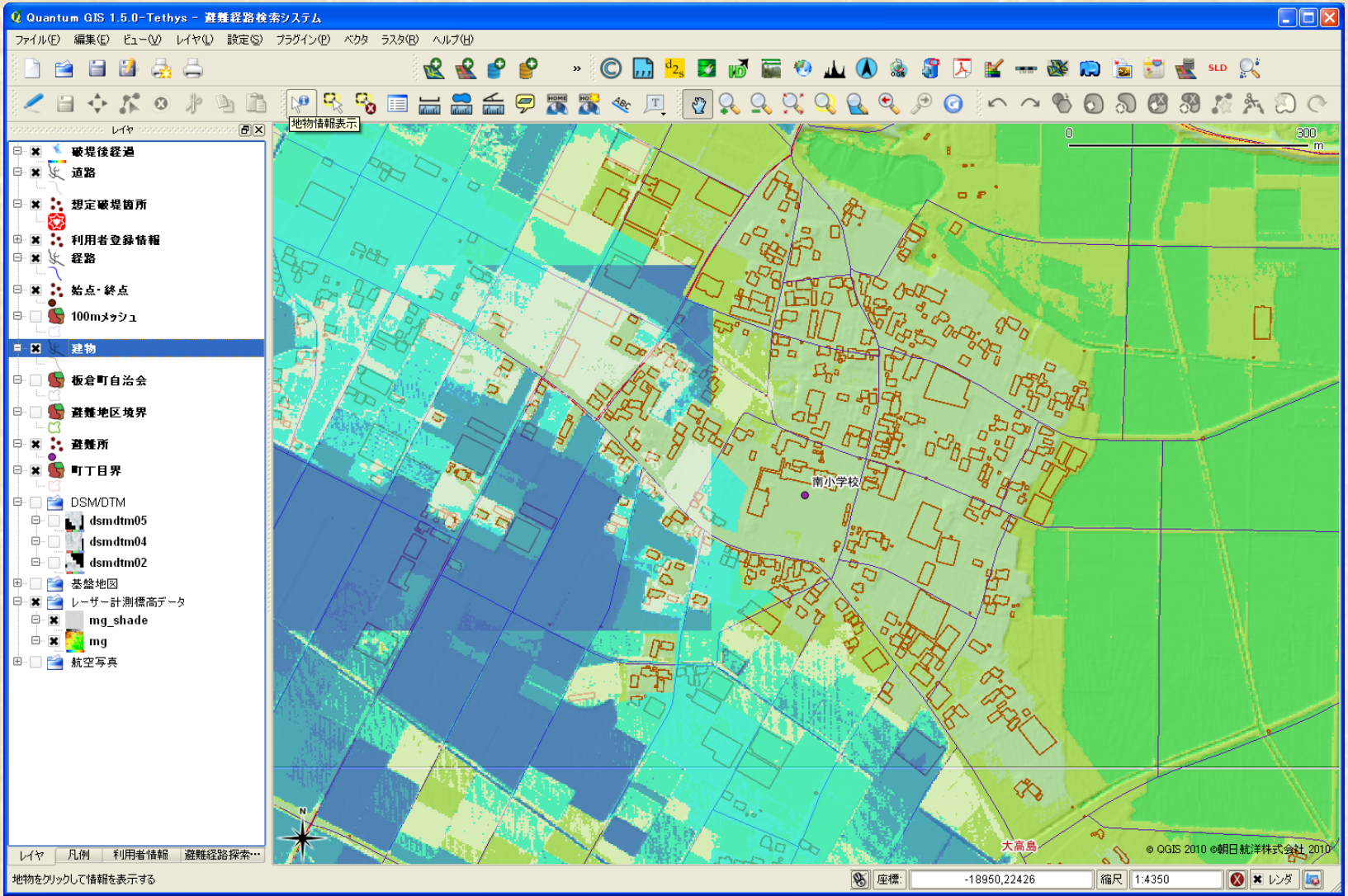
Using 2m grid elevation data from LIDAR ,we could make fine flood area simulation maps



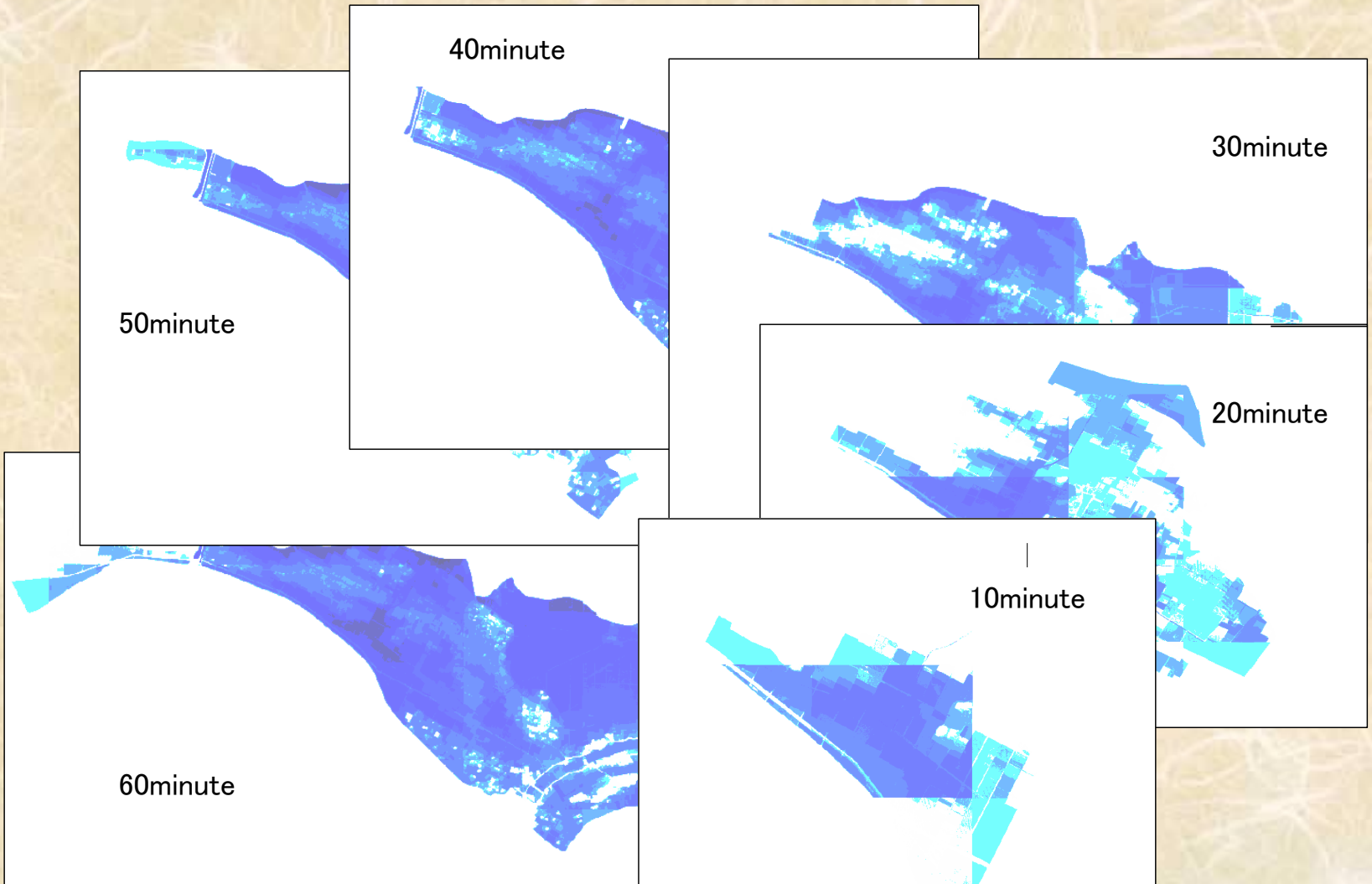
Hight of water surface were Calculated by 250m unit

Water depths were calculated by 2m unit of ground elevation

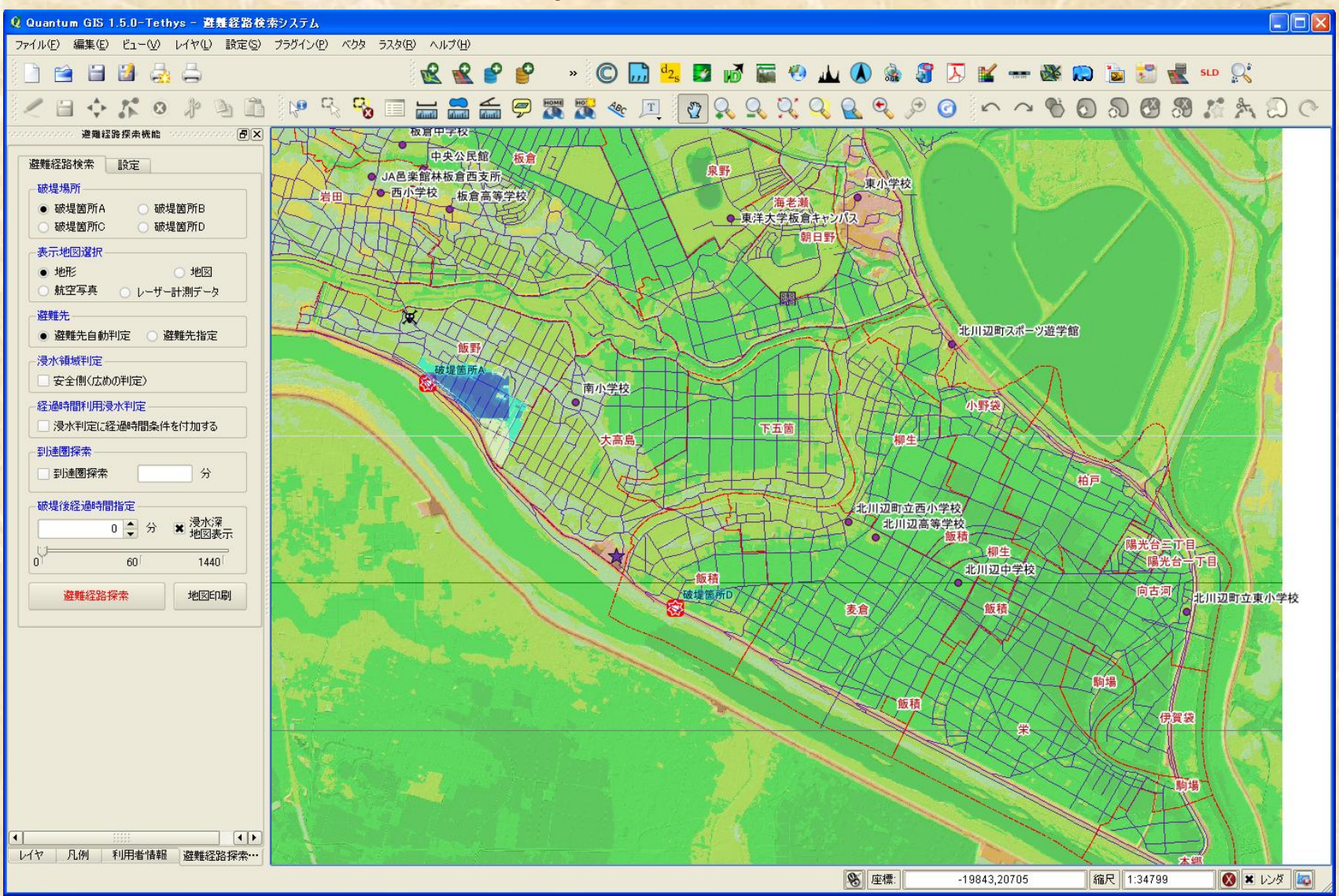
We could get fine flood area map using LIDAR mapping



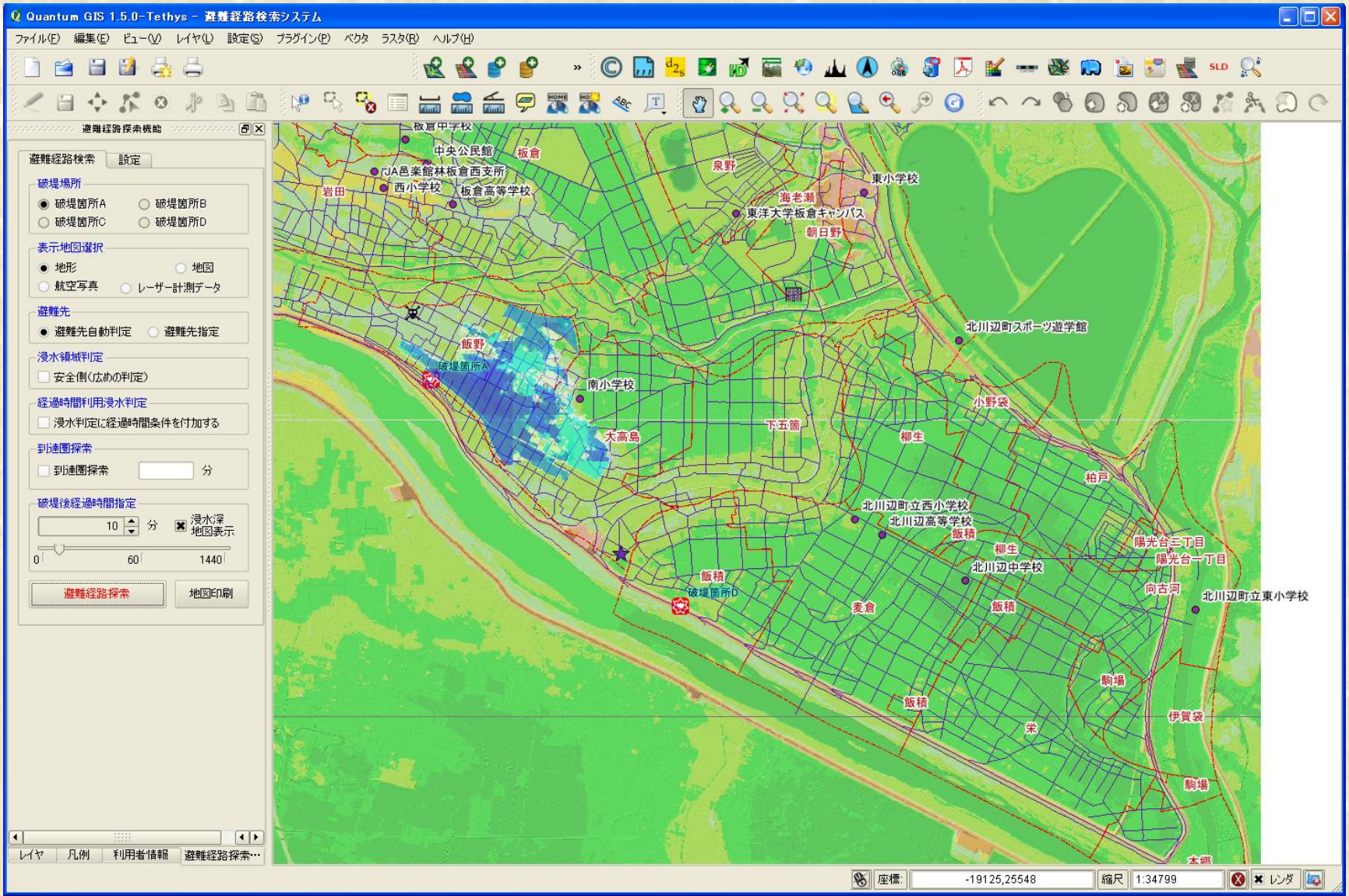
There are many flood area simulation data by 10 minute every assumed place where bank overtopping



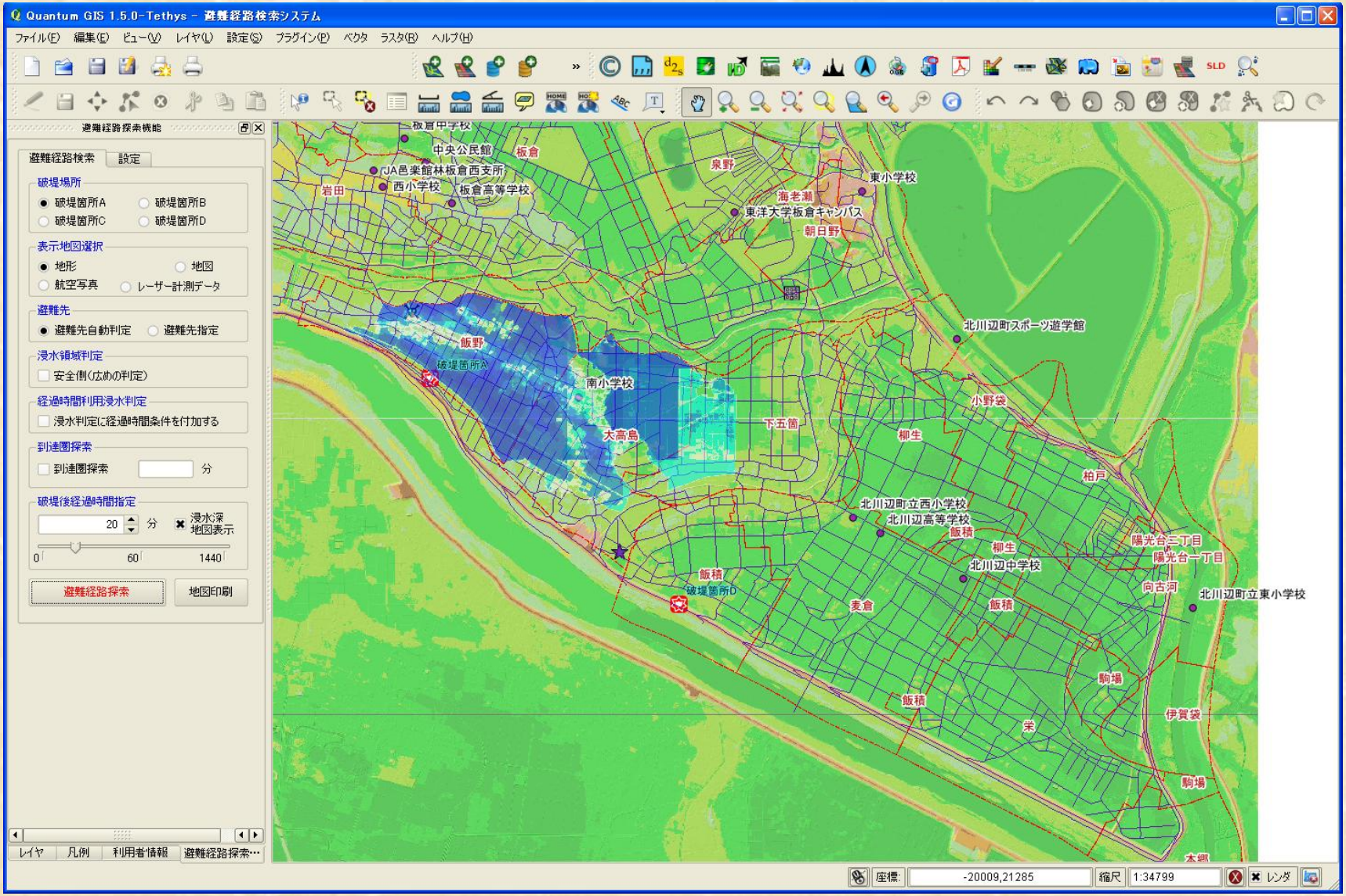
We can see assumed flood area vary with time



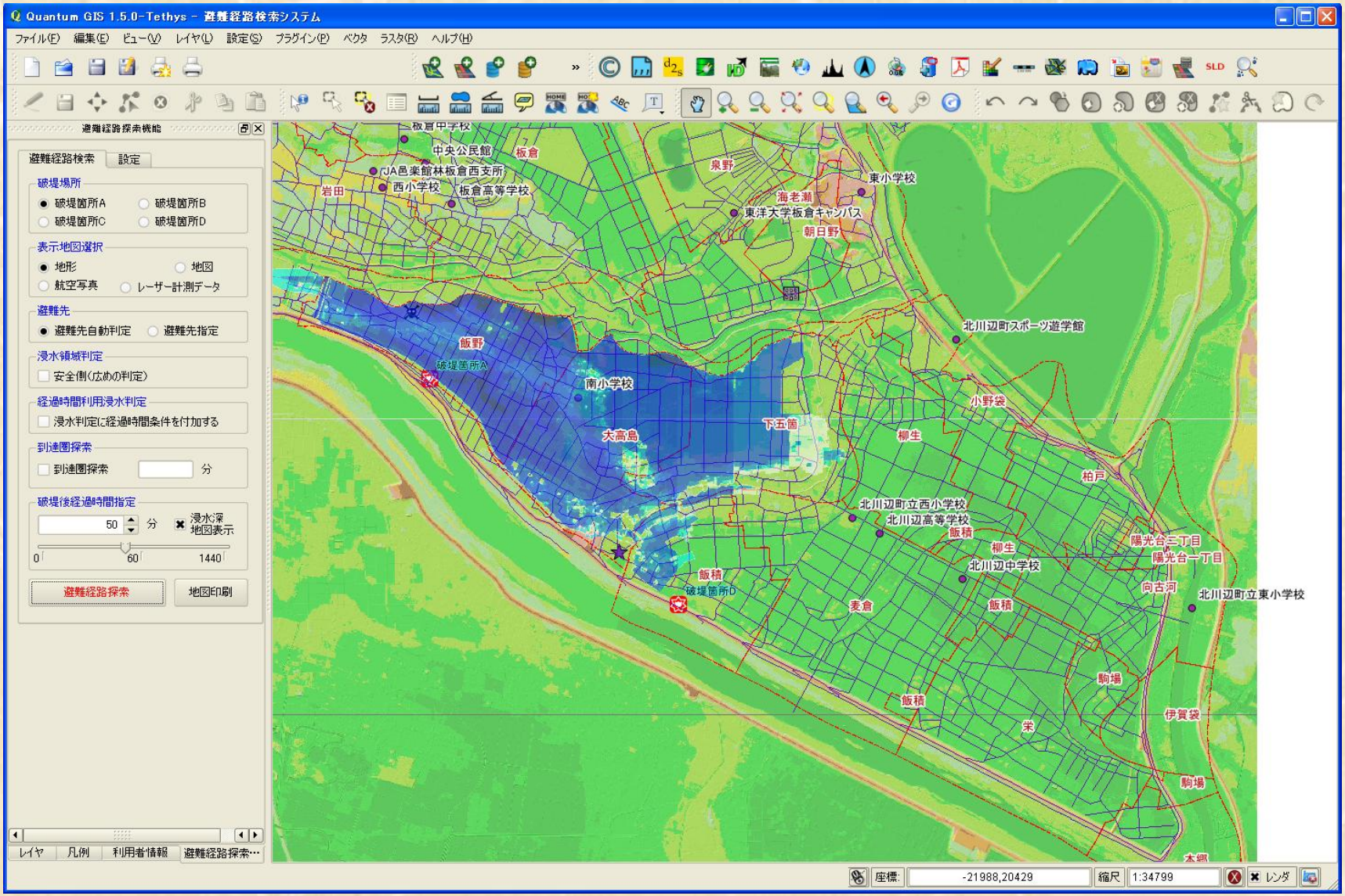
10 minutes later after overflow



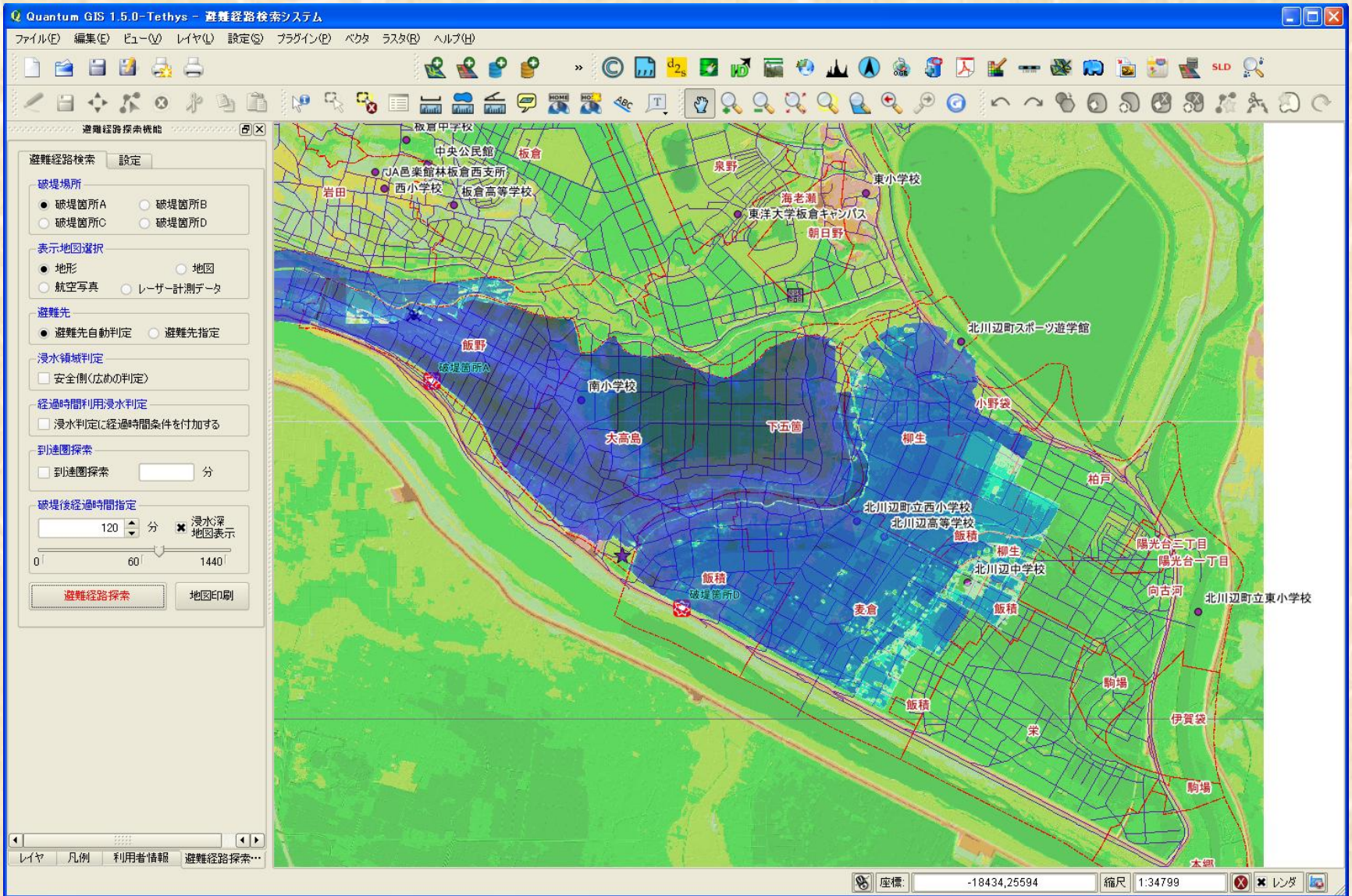
20 minutes later after overflow



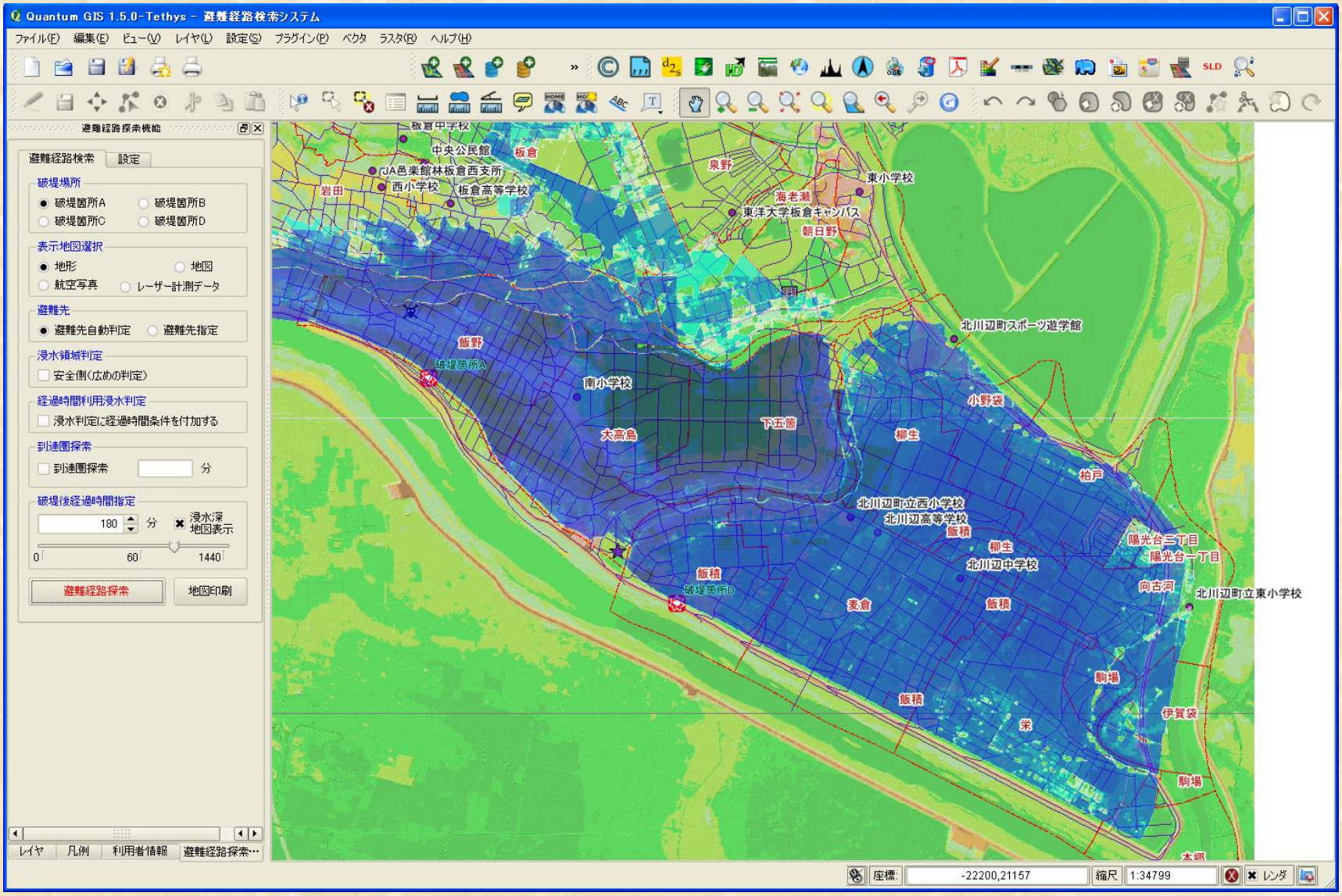
50 minutes later after overflow



120 minutes later after overflow

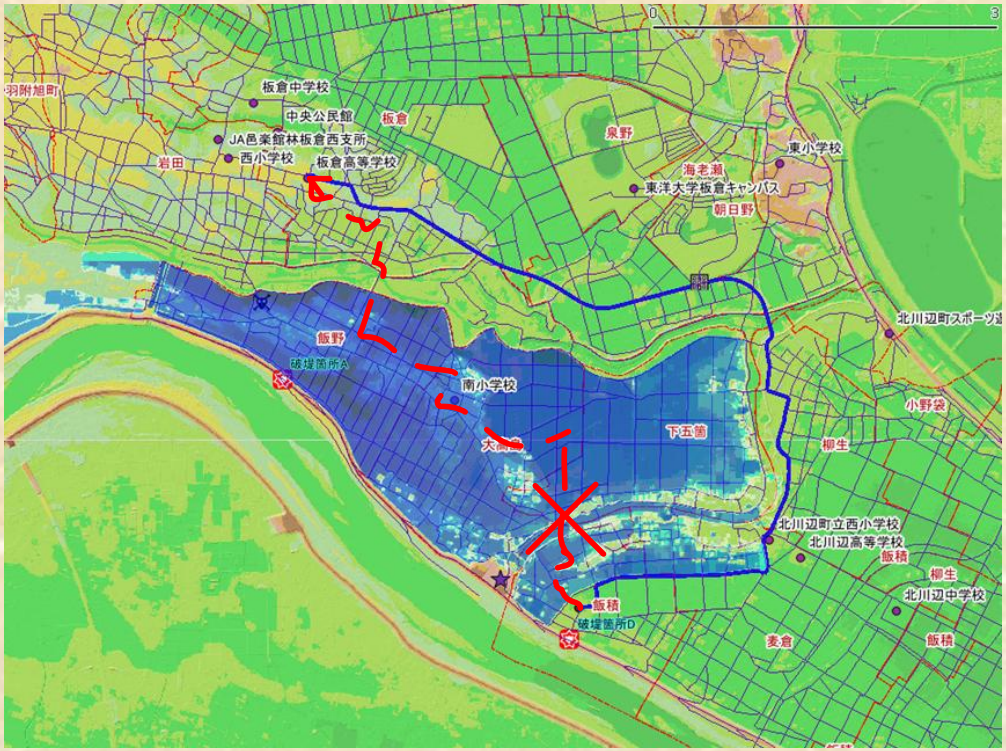


180 minutes later overflow

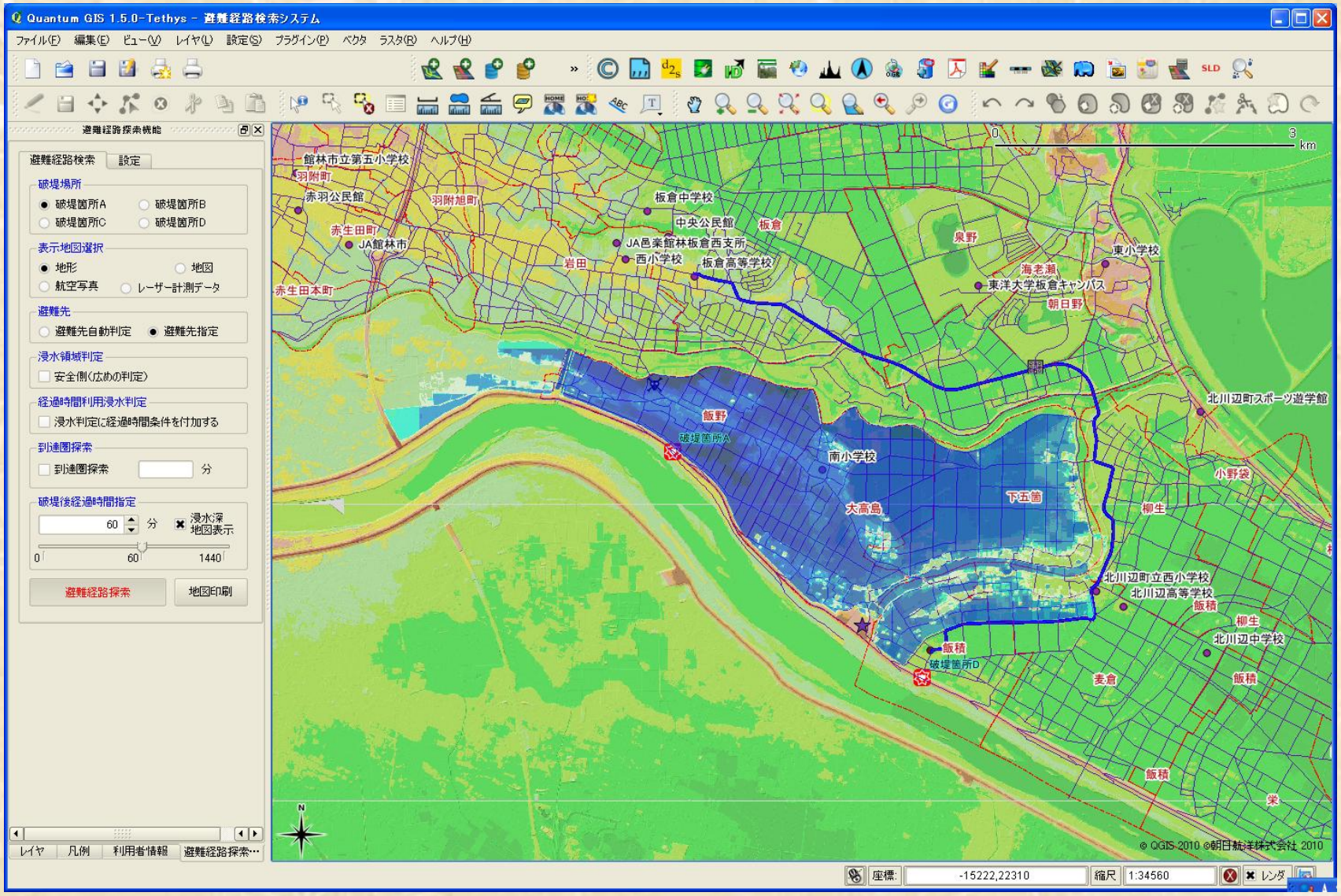


Using such fine flood area data

- If we have network data of roads, I thought perhaps I could make a program of searching route system, without roads of submerged.



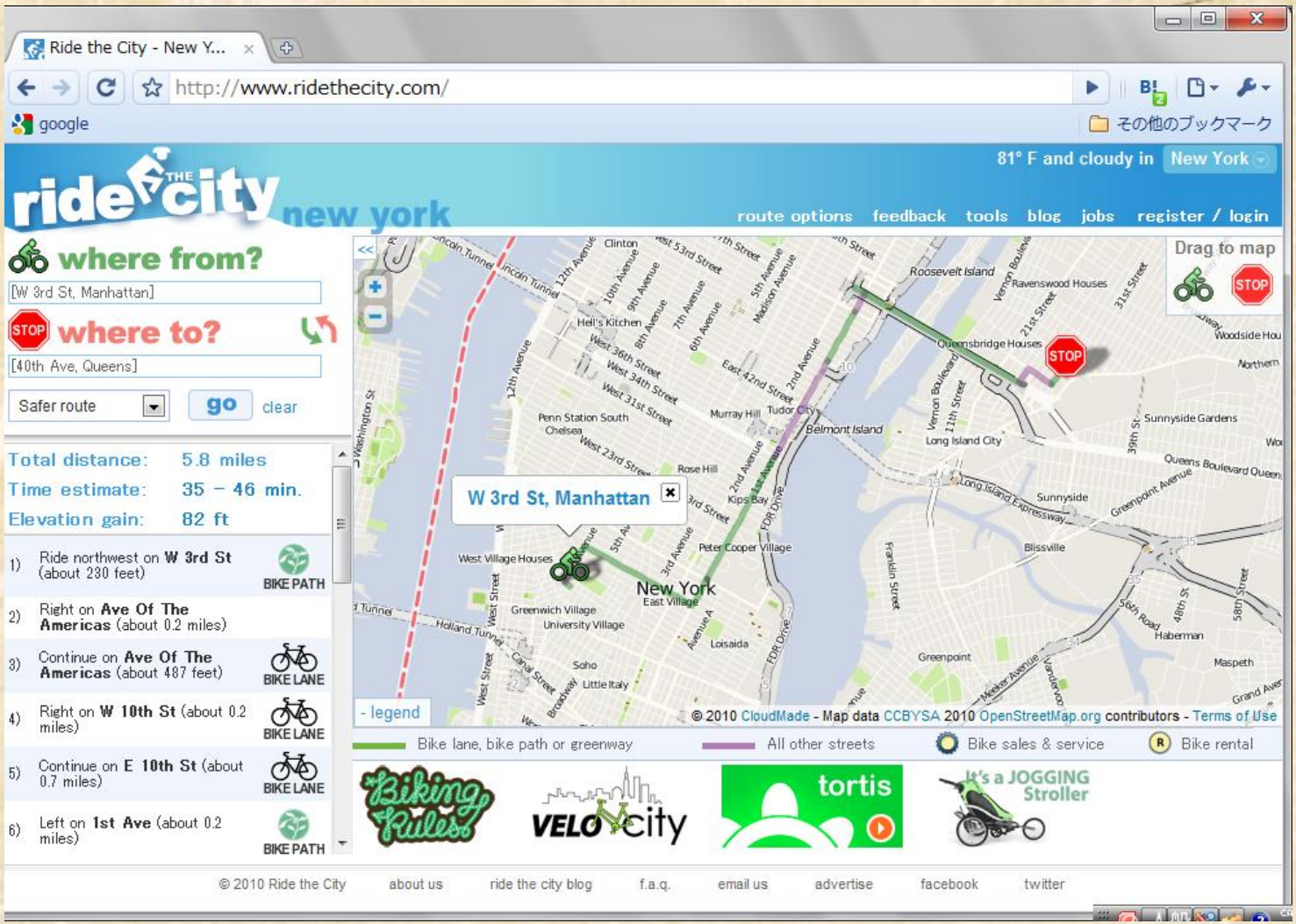
How can I make such system?



When we would make a system about searching route,

- I think, using pgRouting is a best solution .

pgRouting is a excellent program for searching shortest path route



We can add any conditions to the pgRouting search functions as SQL

- Those conditions must be described as SQL of PostGIS/PostgreSQL.
- We can use many spatial relation function at PostGIS.
- So we can add spatial conditions to the search function of pgRouting by using functions of PostGIS.

But !!

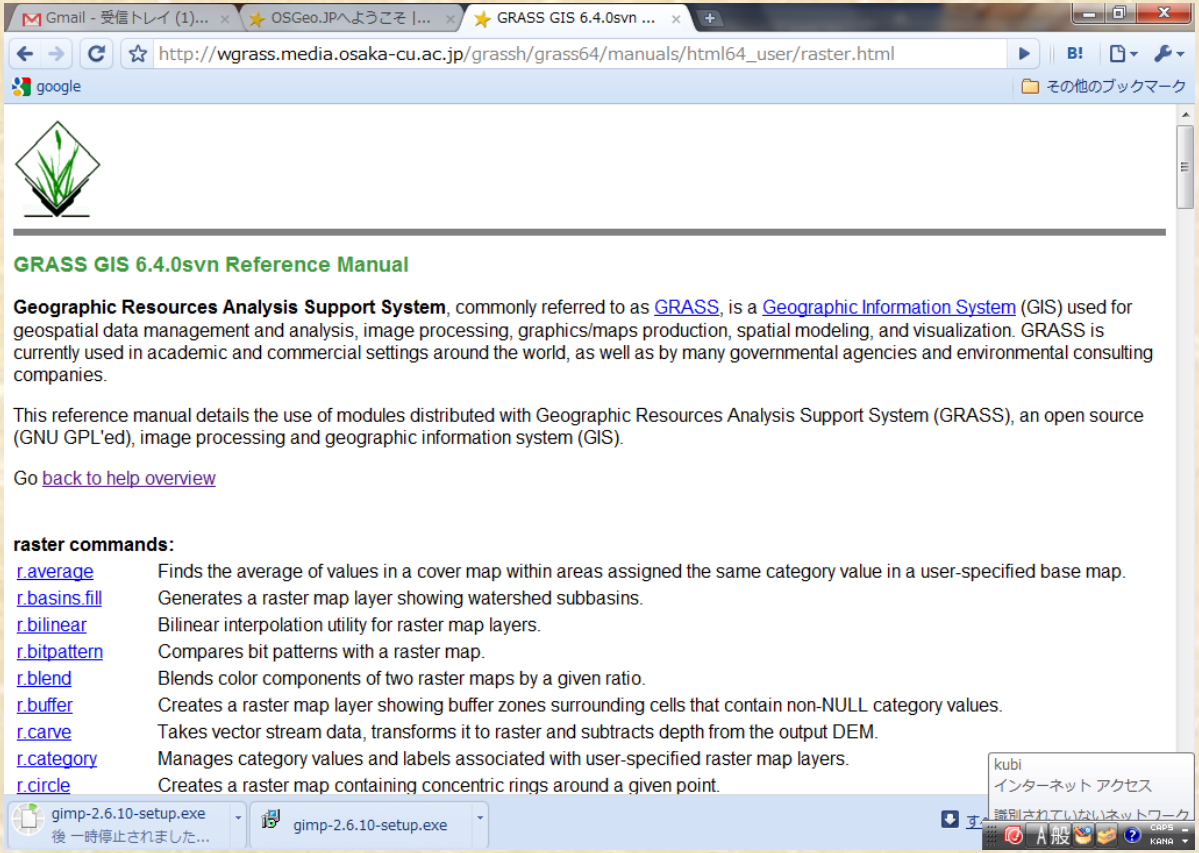
- Using stable version of PostGIS, we can use only vector type geometries.
- We have no functions in PostGIS about raster data now.
- LIDAR data and flood area data are raster.
- So we could not use raster flood area data for spatial functions in PostGIS.

Raster Data
How can I use it with pgRouting?

- If I can change raster of flood area to vector, such as polygon, I could use the polygon data for pgRouting function.
- Are there any program ,have such function ?

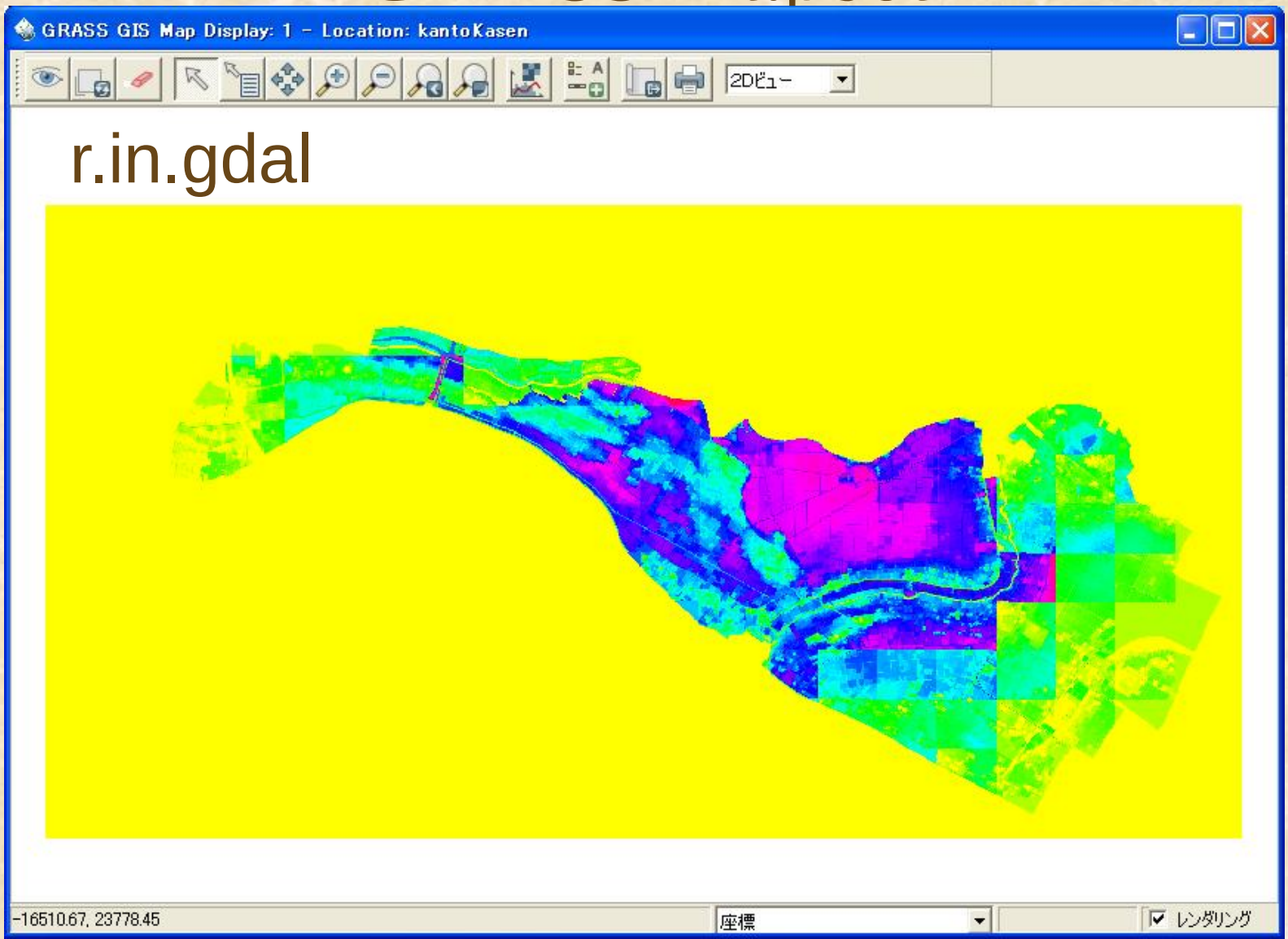
GRASS

- GRASS has many functions about raster and vector spatial data.



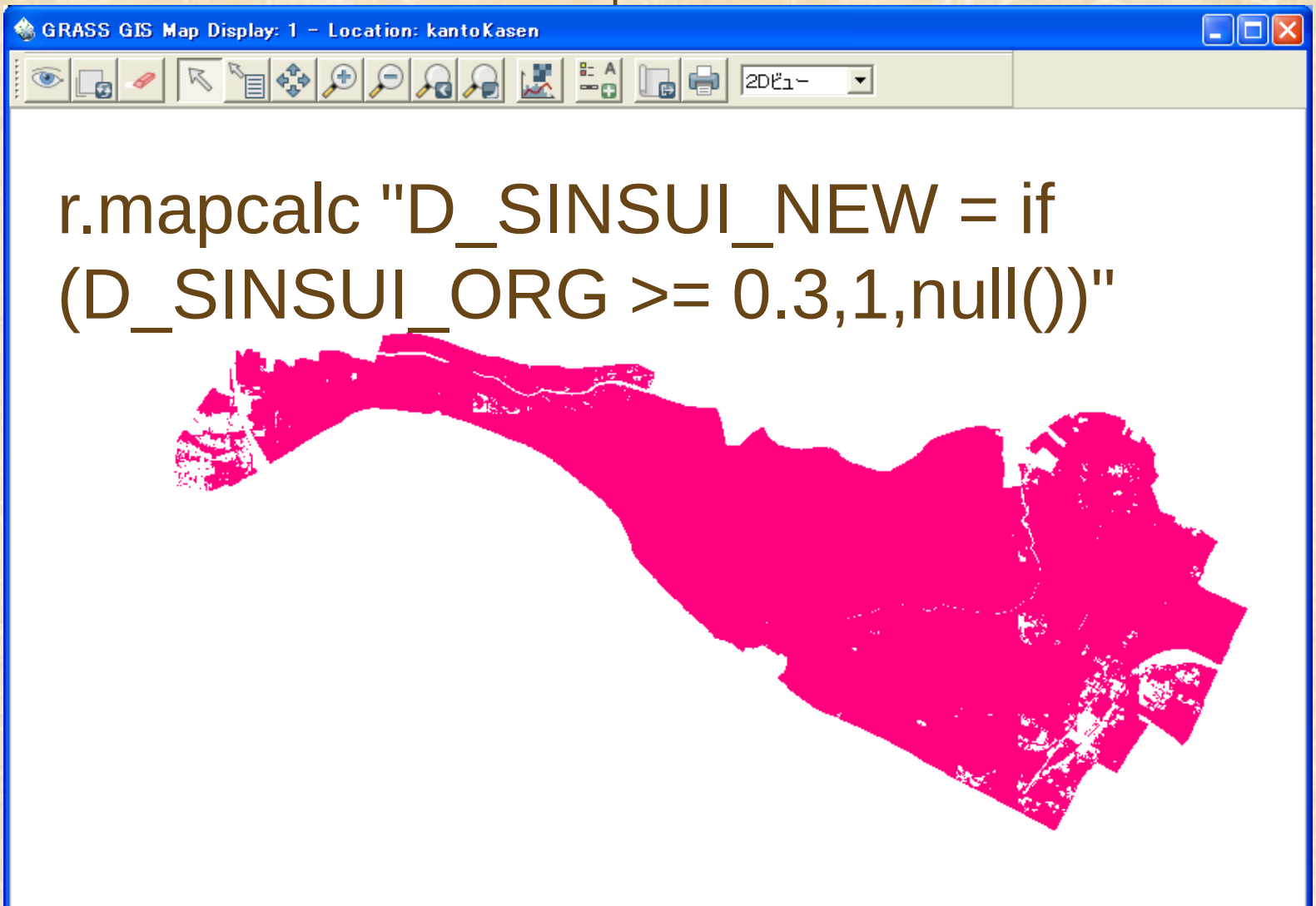
Data conversion process

Import raster of flood area to GRASS mapset

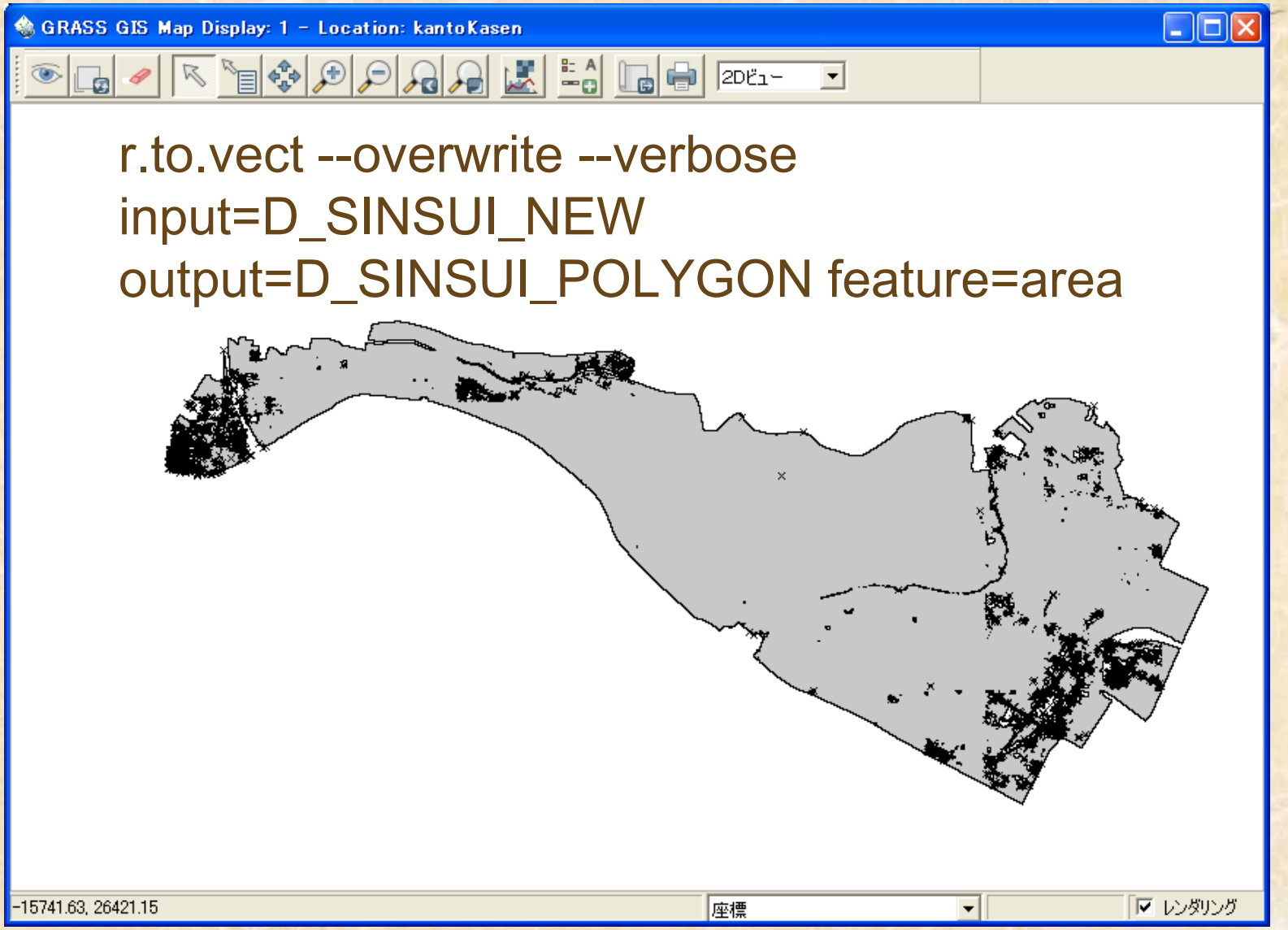


Select the pixels from raster these are submerged =(depth >= 0.3m).

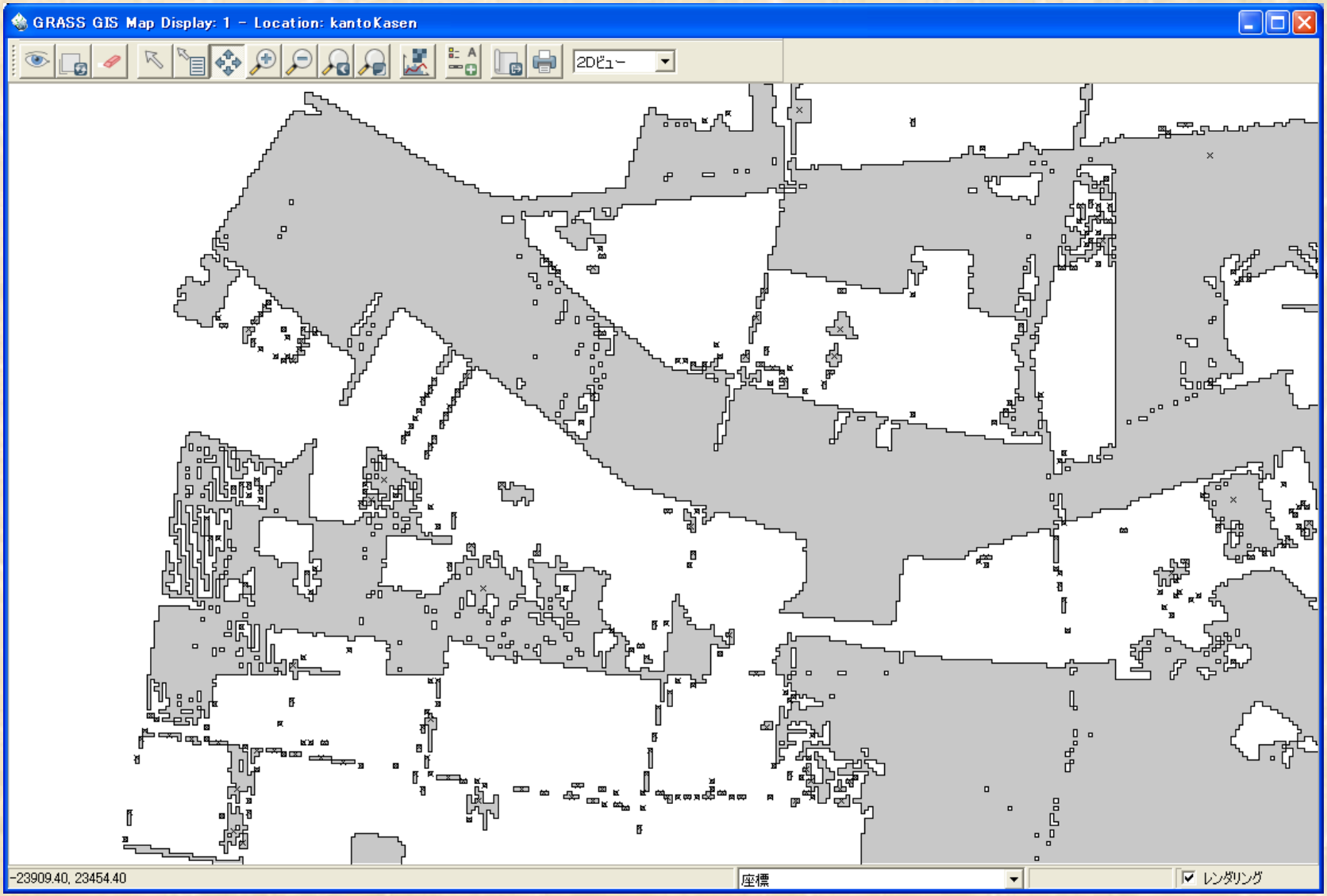
Create a new raster using selected pixels with value 1 and other pixels with null.



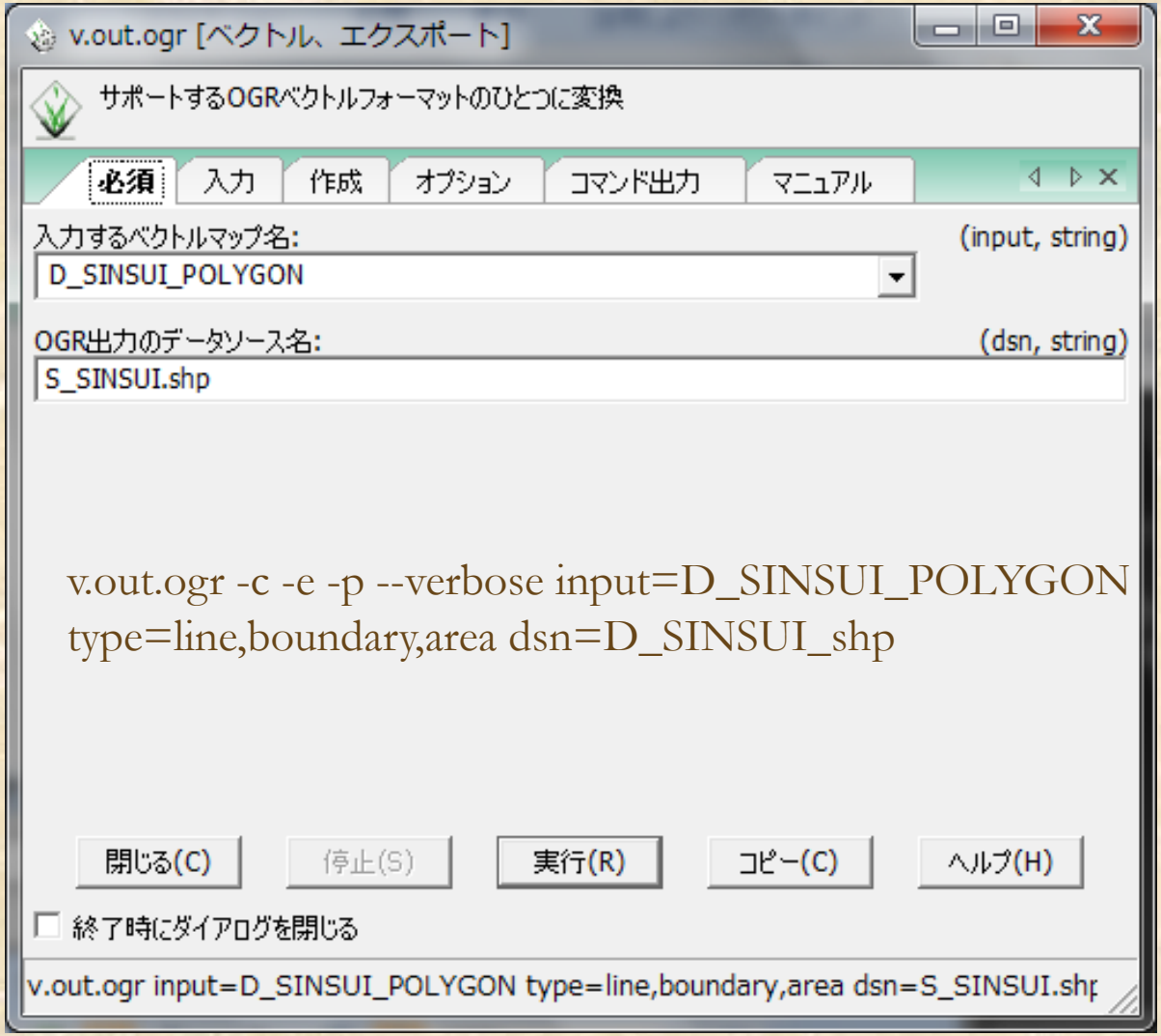
Convert the raster to the vector



Details of created polygon

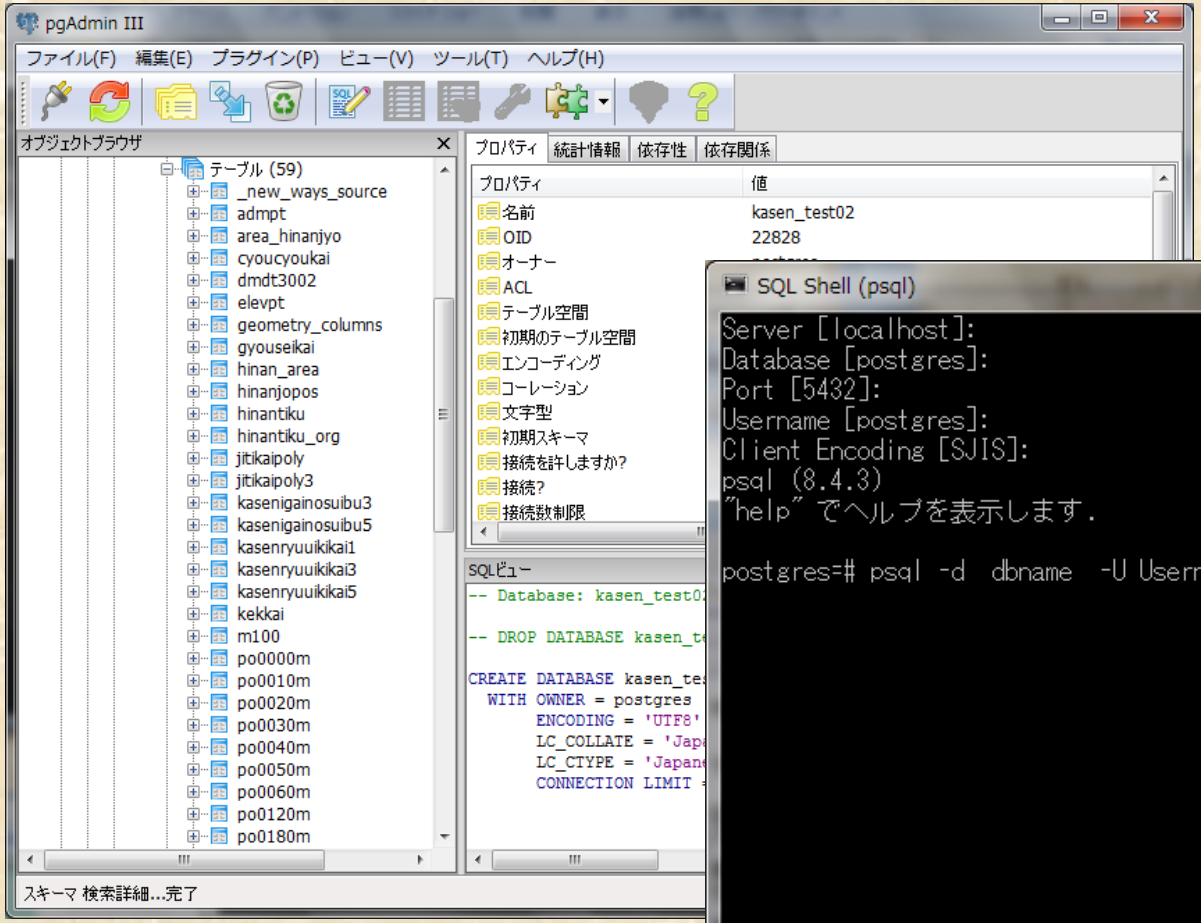


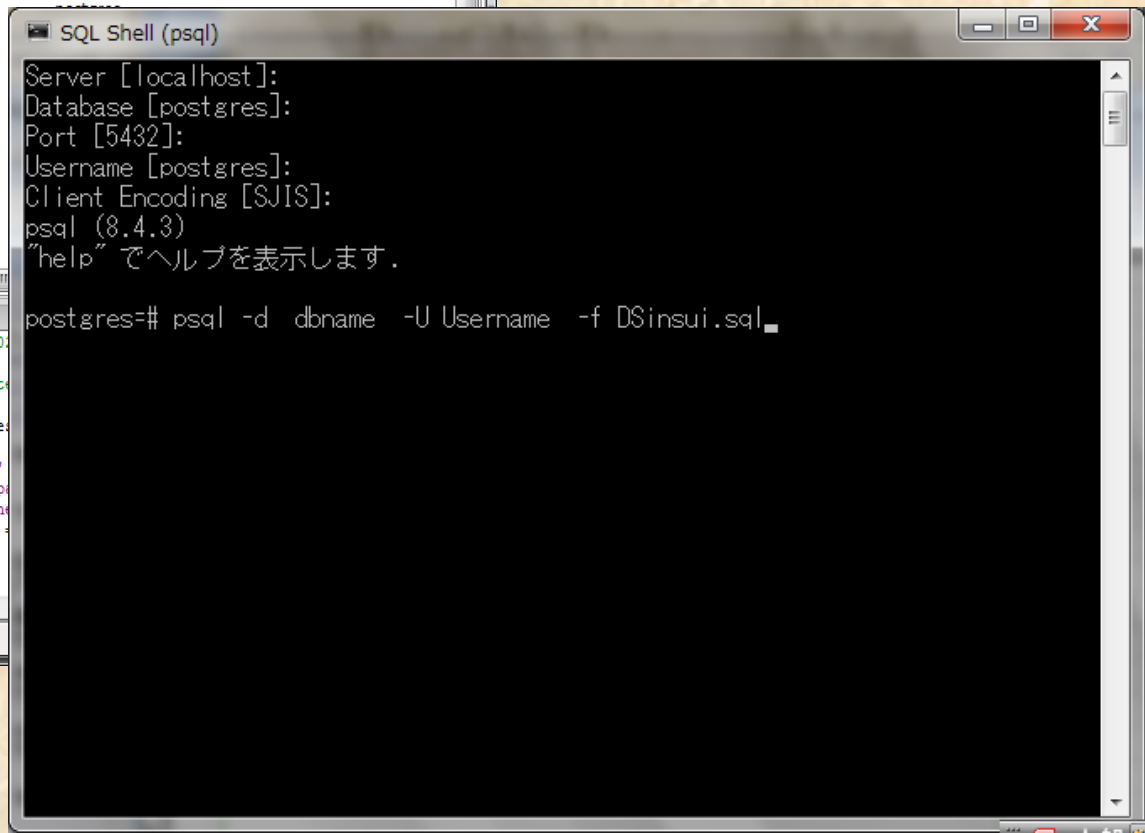
Export the vector of flood area to shape file



v.out.ogr -c -e -p --verbose input=D_SINSUI_POLYGON type=line,boundary,area dsn=D_SINSUI_shp

Load shapfiles to PostGIS/Postgresql database



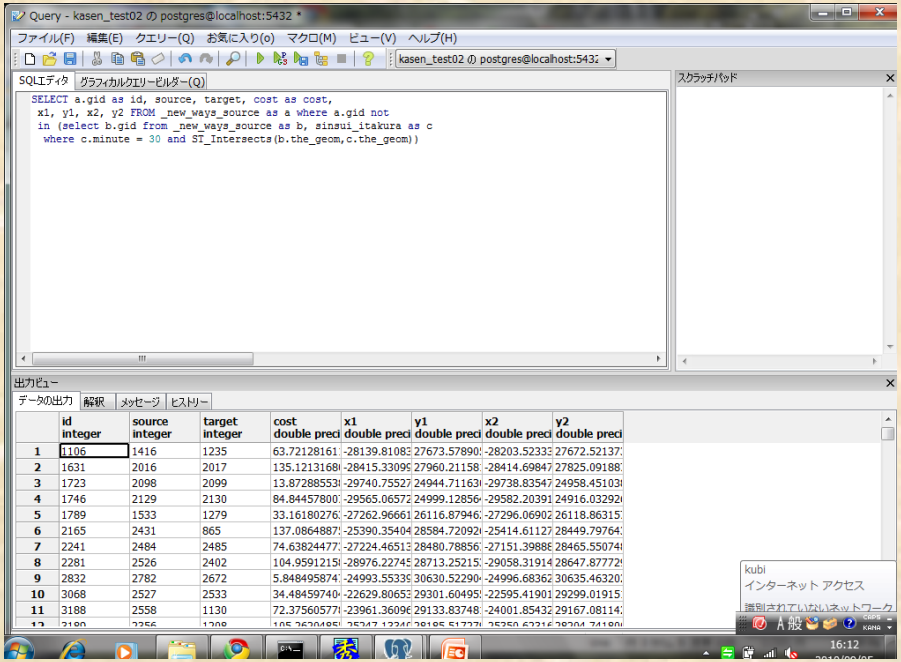


Now we can search using such SQL

```
SELECT vertex_id , edge_id , cost FROM
        shortest_path_astar(                    --  shortest path A star
'SELECT a.gid as id, source, target, cost as cost, x1, y1, x2, y2
   FROM ways as a where a.gid not in( select b.gid from ways as b,
   suishin_polygon_all as c where c.minute = 30
                                --  after 30 minute from bank break
  and ST_Intersects(b.the_geom,c.the_geom))'
                        -- is geometries intersect?  a function  of PostGIS
 ,4799, 3962, false, false)
          /* source id, target id, directed, has reverse cost */
```

Using pgRouting

- We can search route with network data
- But there are query results strings.
- There are no maps of route using only pgRouting.
- How we can see the maps of routes ?

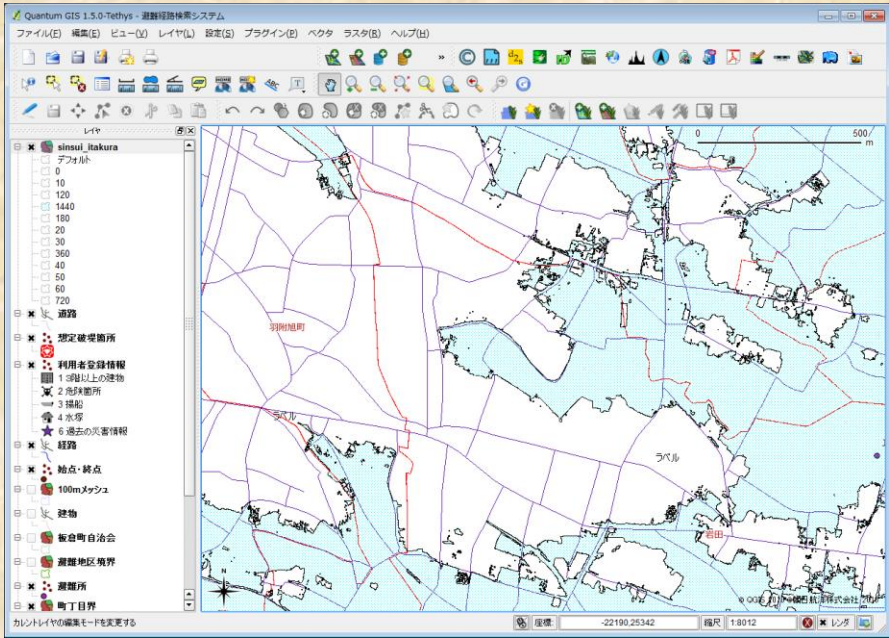


There are may ways of make a map for pgRouting

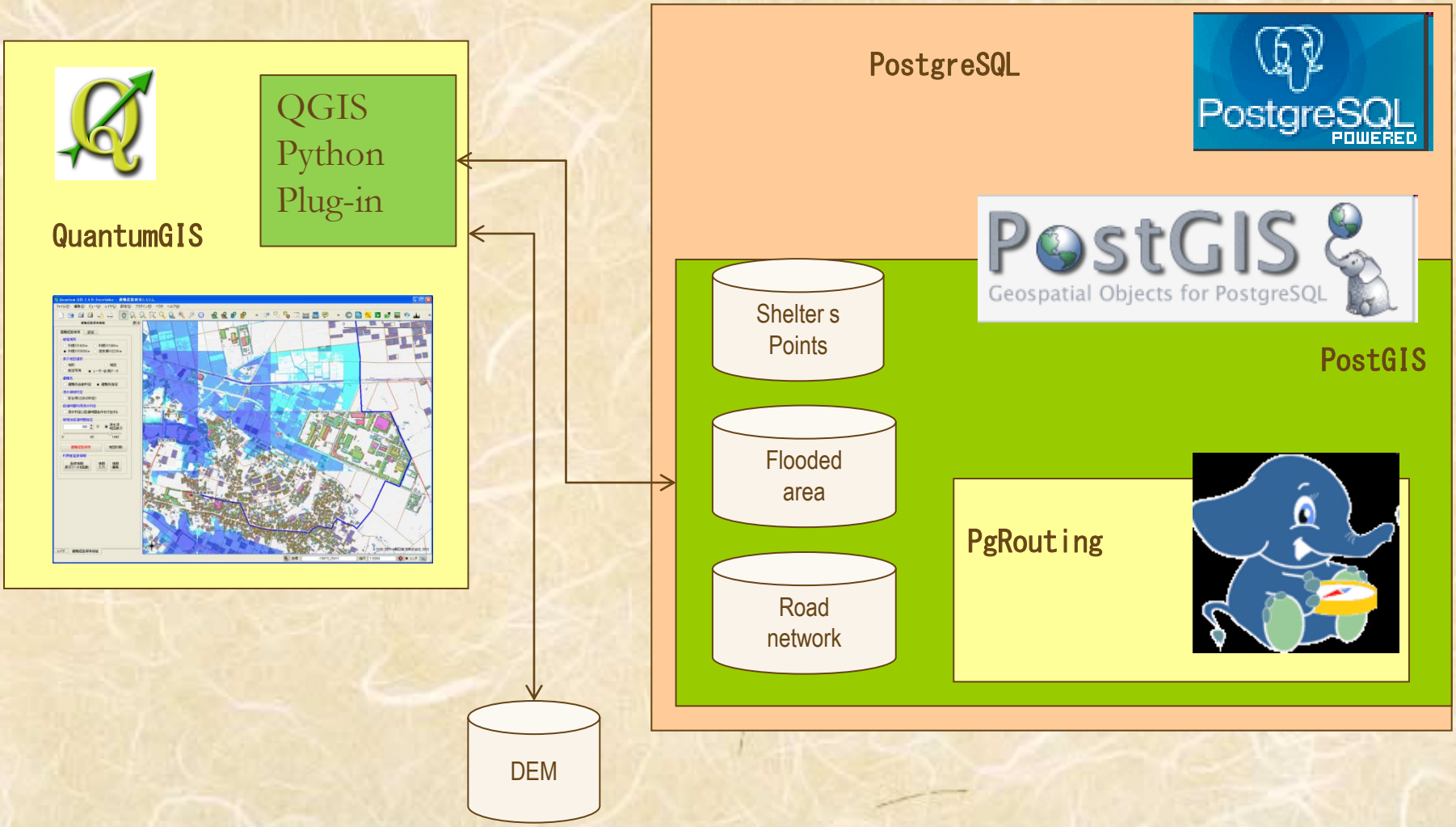
- Web Mapping such as OpenLayers are cool method.
- There are some good desktop GIS tools such as QGIS, uDig, gvSIG, Open JUMP etc……
- Perhaps we can see a map ,that contain result of using pgRouting, with such good FOSS4G products.

I used QuantumGIS for this system

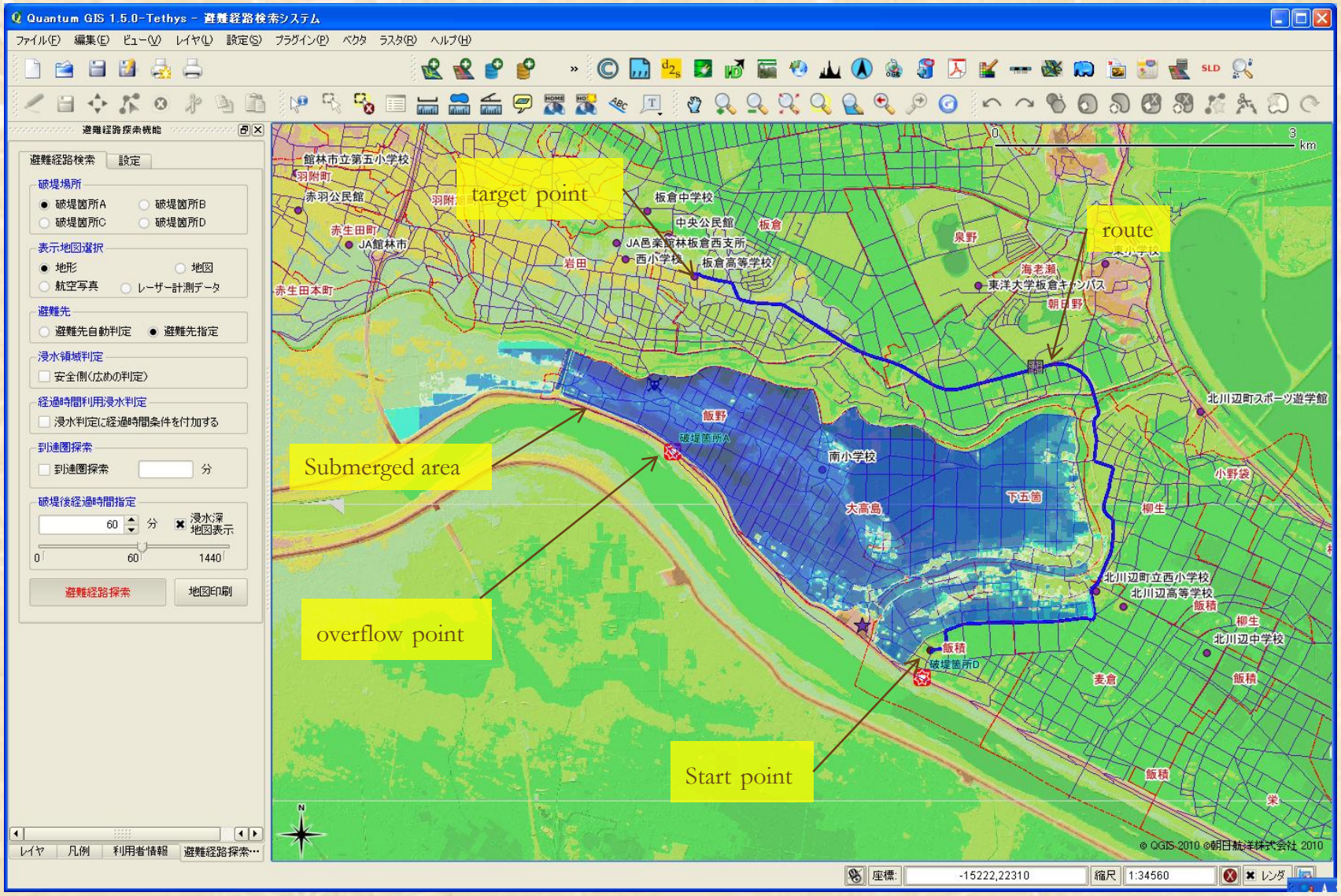
- Stand alone use(without internet) is required
- There are Japanese GUI(we transrated)
- We can add functions as external plug-in program to QuantumGIS.



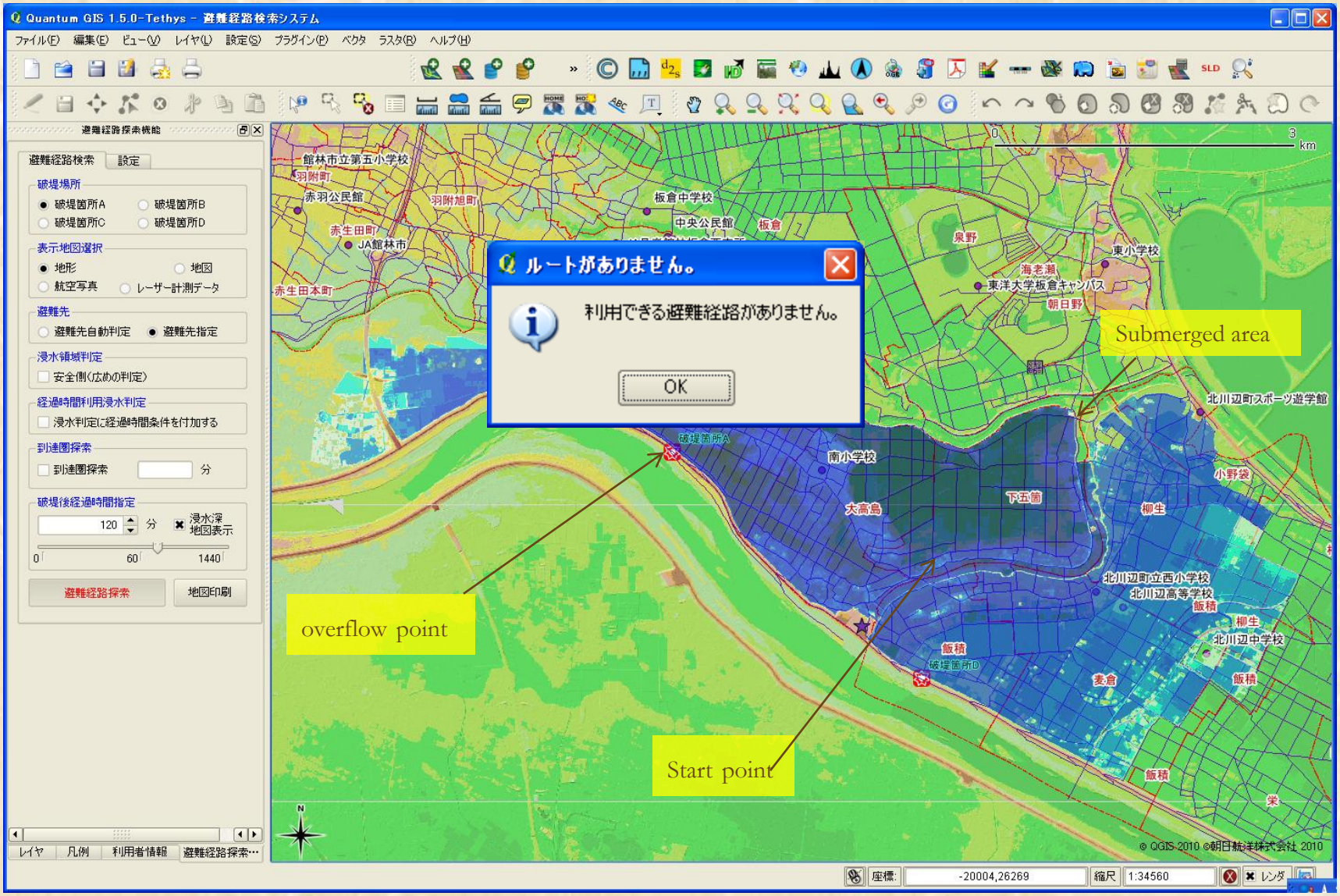
A system using pgRouting



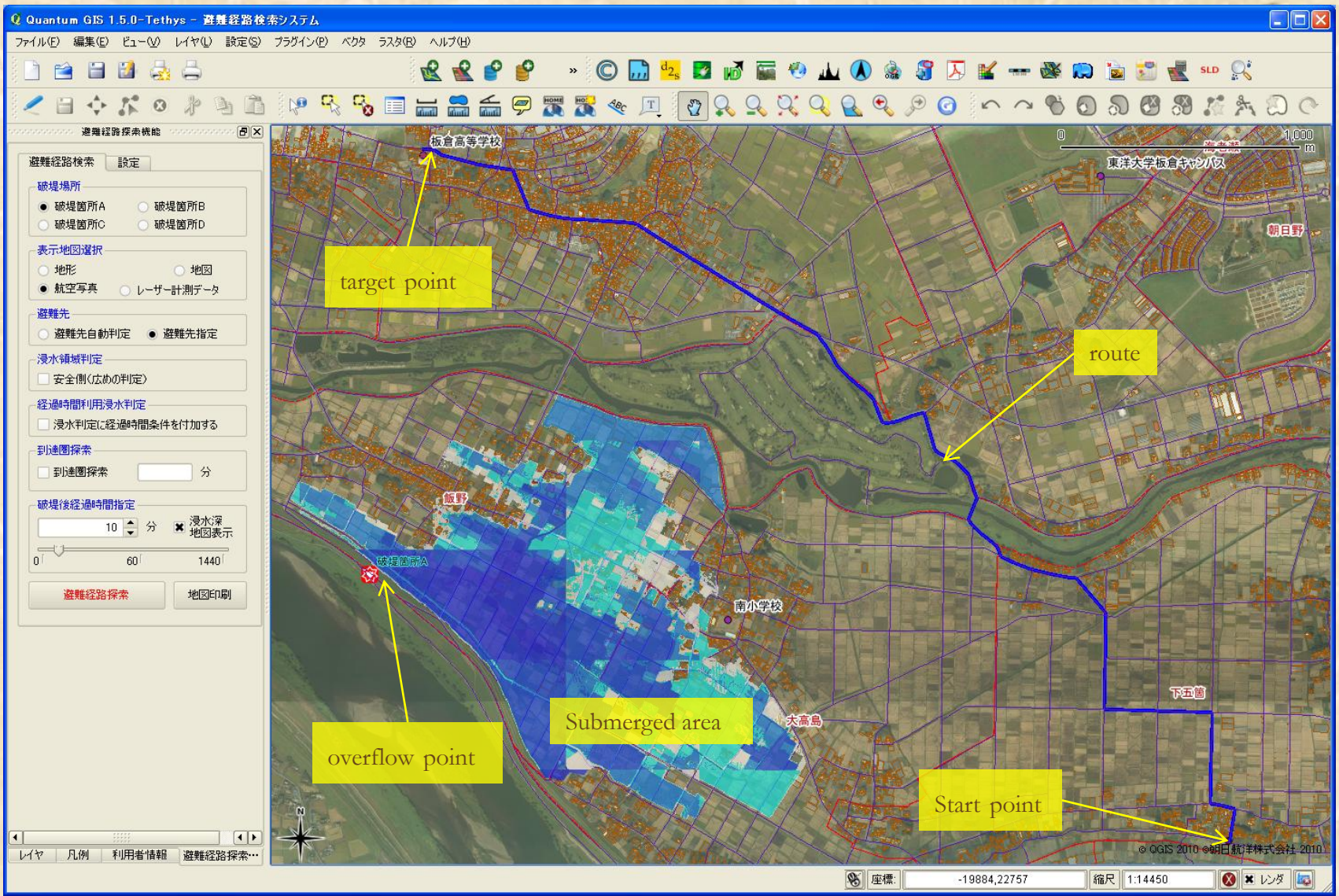
Route to a shelter



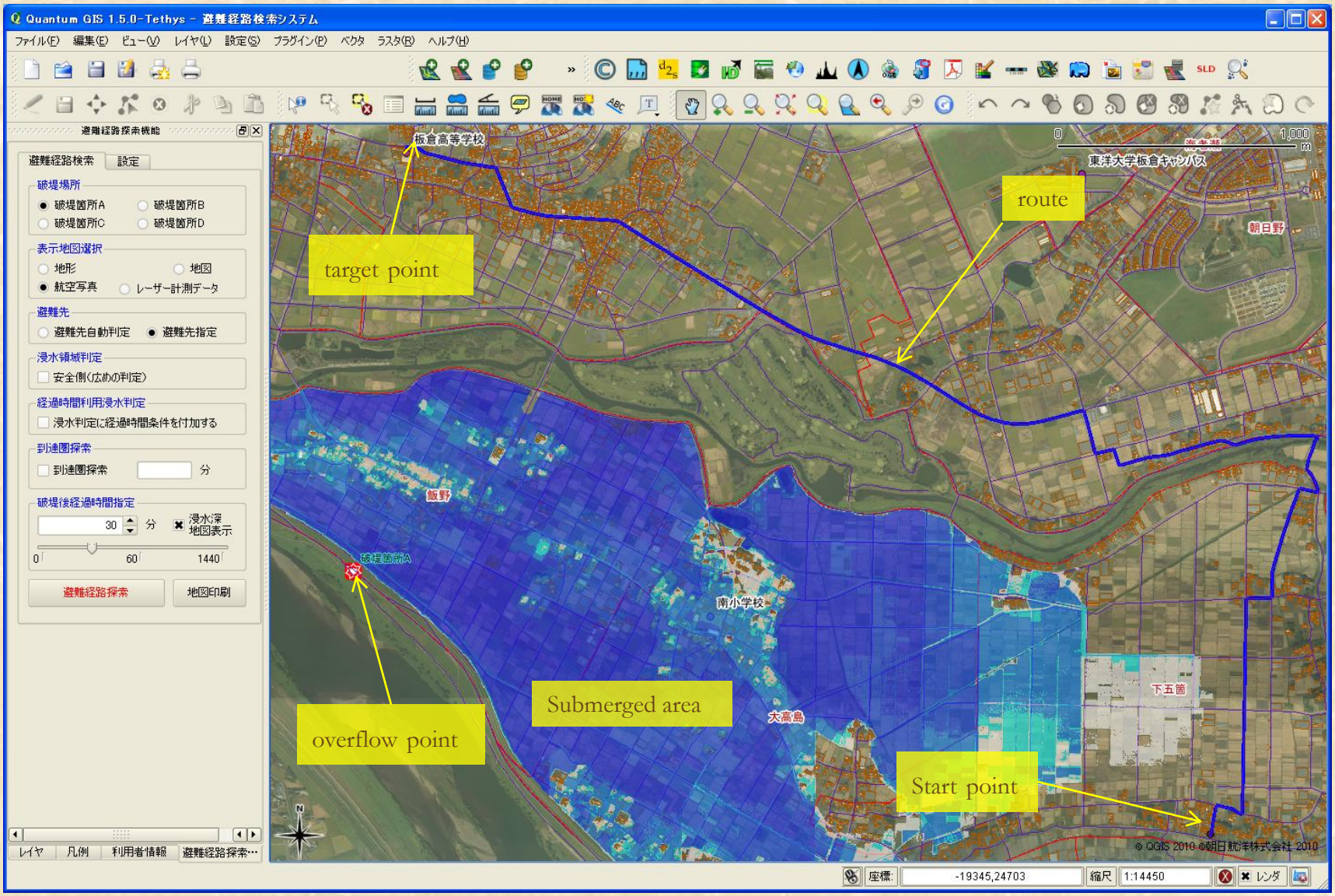
There are no route to any shelter



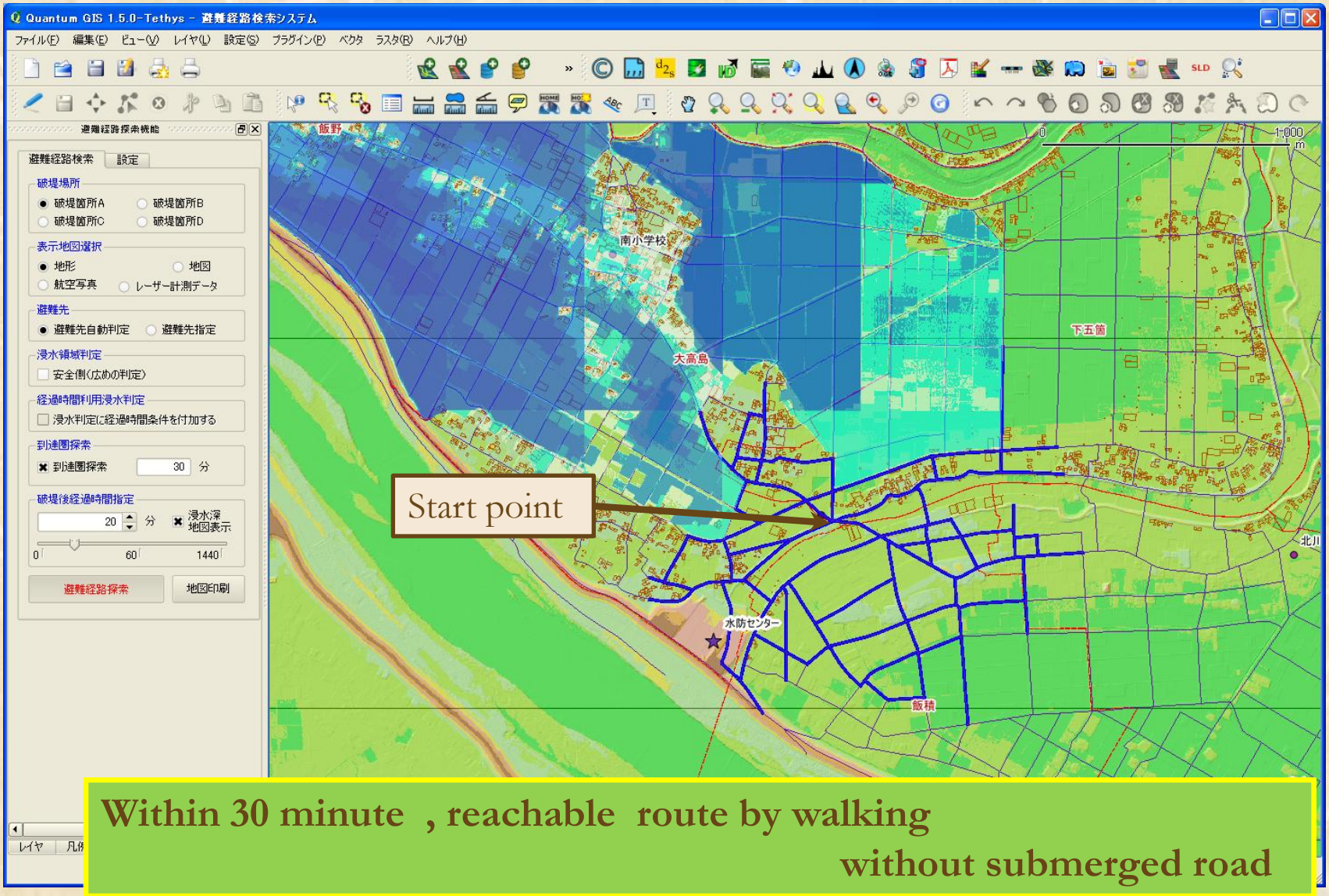
10 minutes later after overflow



30 minutes later after overflow



Driving distance calculation



Within 30 minute , reachable route by walking without submerged road

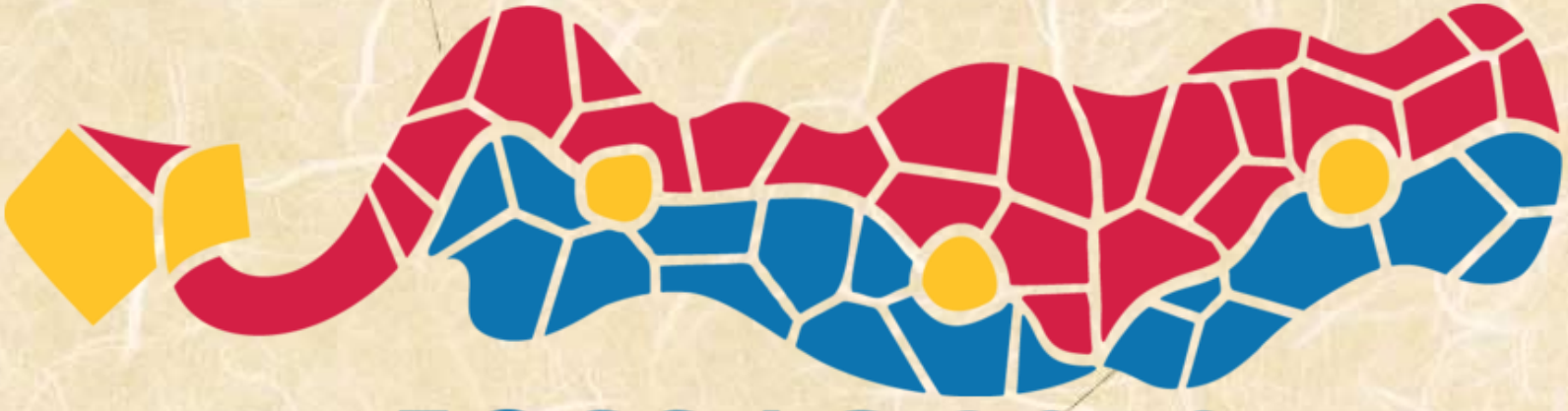
Demo ?

Using FOSS4G products

- Without FOSS4G we would have been difficult to obtain tools for such spatial data usage.
- pgRouting, PostGIS/PostgreSQL, GRASS, QGIS have excellent functions for our works.
- I think when we want to use some functions about spatial data, make combination of some FOSS4G product is best solution.

- This system made for The Ministry of Land, Infrastructure, Transport and Tourism Japan, Kanto Regional Development Bureau.

Thanks for your attention



FOSS4G 2010

Barcelona

Monday 6th through Thursday 9 September, 2010