# A study about optimization of NHM for using on K computer
# and
# Flash flood simulation for several small rivers in Kobe

## NHMの京への最適化に関する考察
## と
## 神戸の複数の小規模河川を対象にした洪水シミュレーション

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# A study about optimization of NHM for using on K computer

Background

- In the history, the NHM has been developed on the vector type computer.
- The architecture of the K super computer is scalar type and therefore we need to optimize the NHM to the scalar type.

- We are improving the model with Fujitsu team.
- We have finished analysis and tuning of top 40 loops of high computation cost.

# Tuning process and performance test process

- The original NHM is version 2011.
- The Fujitsu team analyzed IO the NHM and found inefficient 40 loops as improvement target loops.
- Performance test conduct on the K computer.
- The improved NHM and two functions in the NHM have tested in the K.

# Items of the performance test

- Experimental conditions
- Grid size: 2km
- Domain size: (x, y, z=800, 550 50)
- Simulation period: 1 hour on 2011/07/28
- Outer model: 5km

Improvement methods
OpenMP
Do loop and If sentence in the source codes
cash tuning for reducing cash miss.

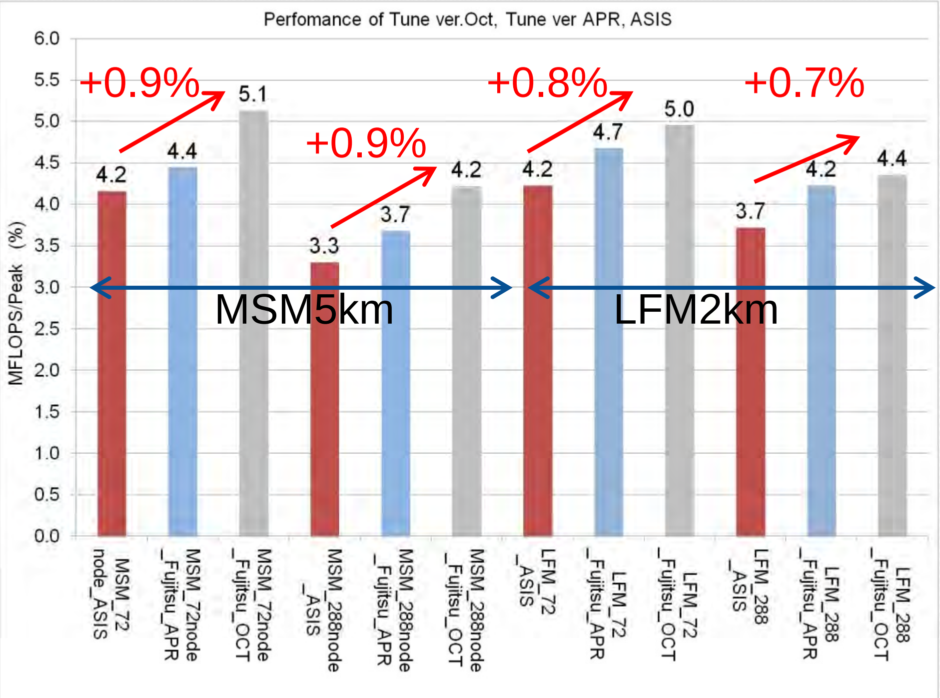
Performance test Items

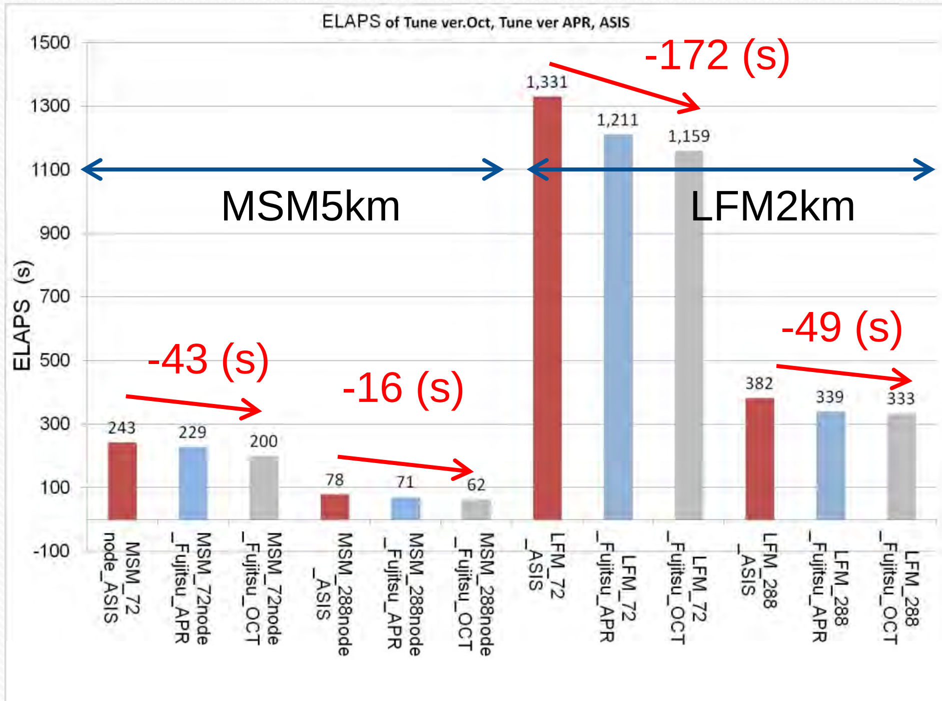
- ➢Original NHM and improved NHM
- ➢To dedicated node for output
- ➢Save memory function

# improvement effect of the NHM

Measure segment: Physical computation part in main loop (excluding initial files and output)
Computation step: MSM 5km 450 step (3hr forecast)
LFM 2km 1080 step (3hr forecast)

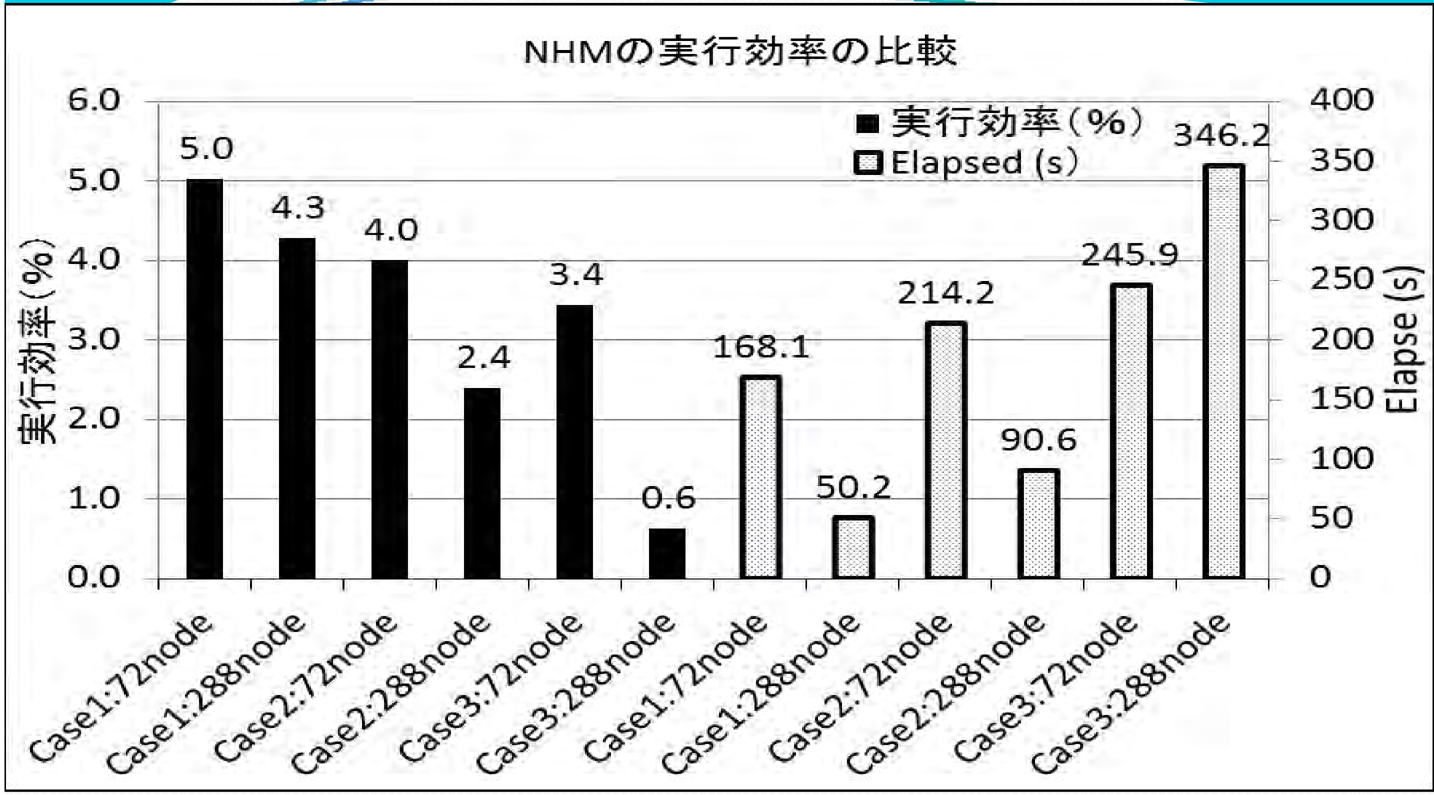
Red: Tuned NHM_ver.OCT2012
Blue: Tuned NHM_ver.APR2012
Gray: Original NHM_ver.2011




The peak performance ration increase about 0.7-0.9%

# Practical cases



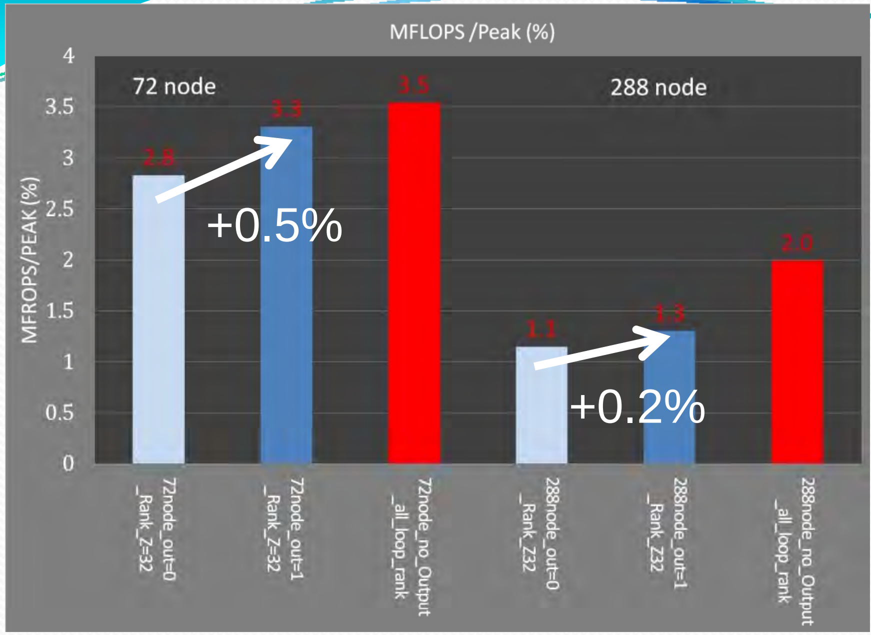

Case 1 : To measure physical computation part in the main loop excluding initial files and file output.

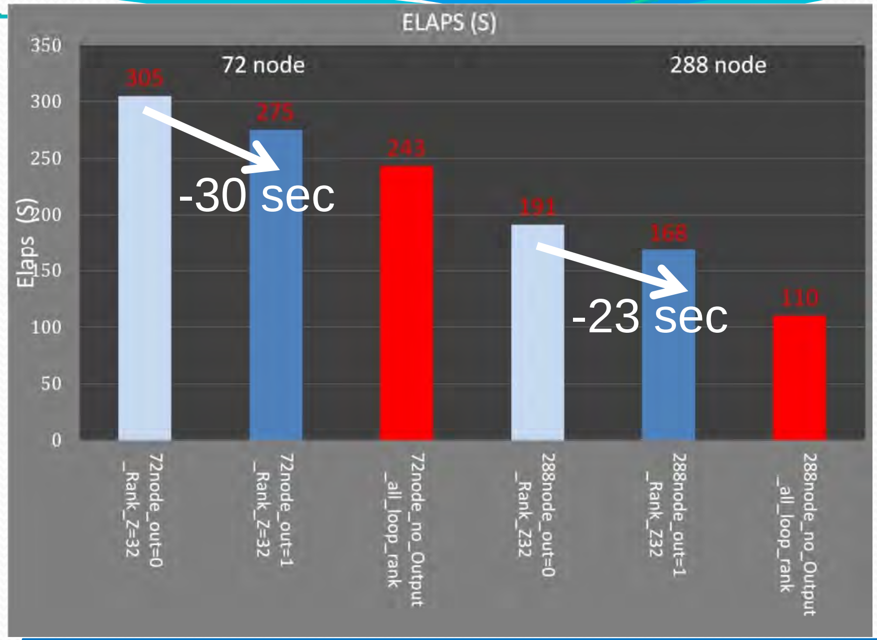
Case 2 : To measure all of main loop excluding file output.

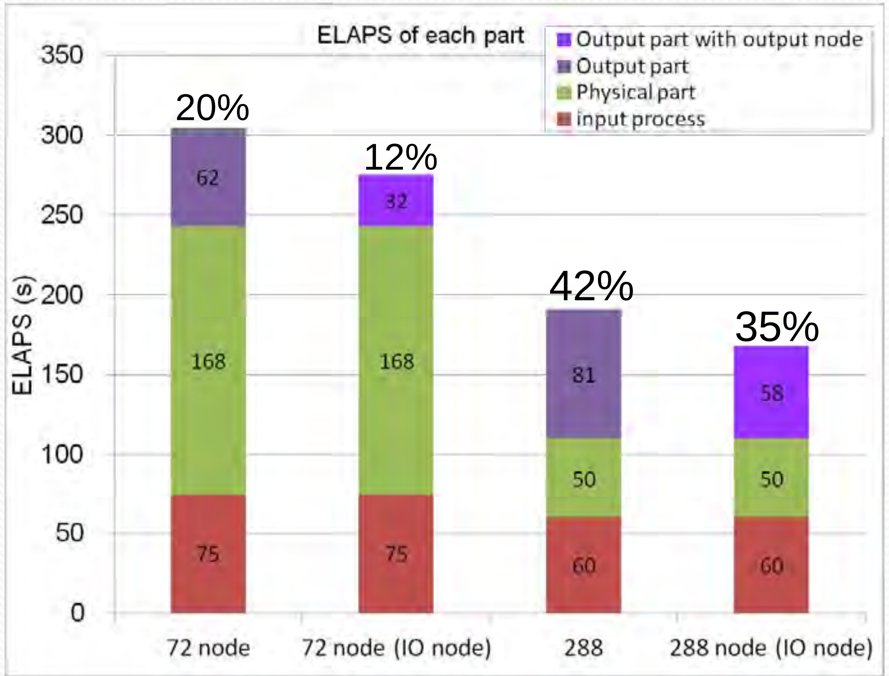
Case 3 : To measure all of main loop

- The Case 1 and 2 showed expected result due to increase computation speed.
- However, in the Case 3, the computation speed were decreasing although nodes were increasing.
- We conclude the reason of the Case 3 is that IO communications between IO node and each nodes were increasing and computation burden of IO node were increasing. Increased elapsed time effected the peak performance ratio.
- The results indicate the computation performance will decrease due to IO process in the large size computation.
- To improve IO part in the NHM is necessary for effective operation in the K.

# Impact of dedicated node for output



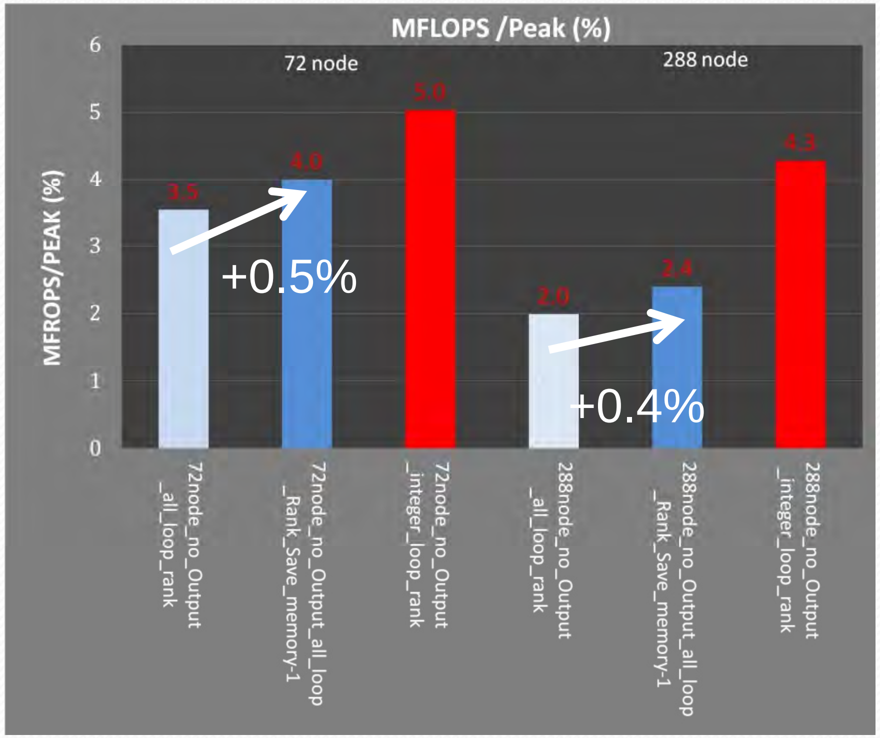



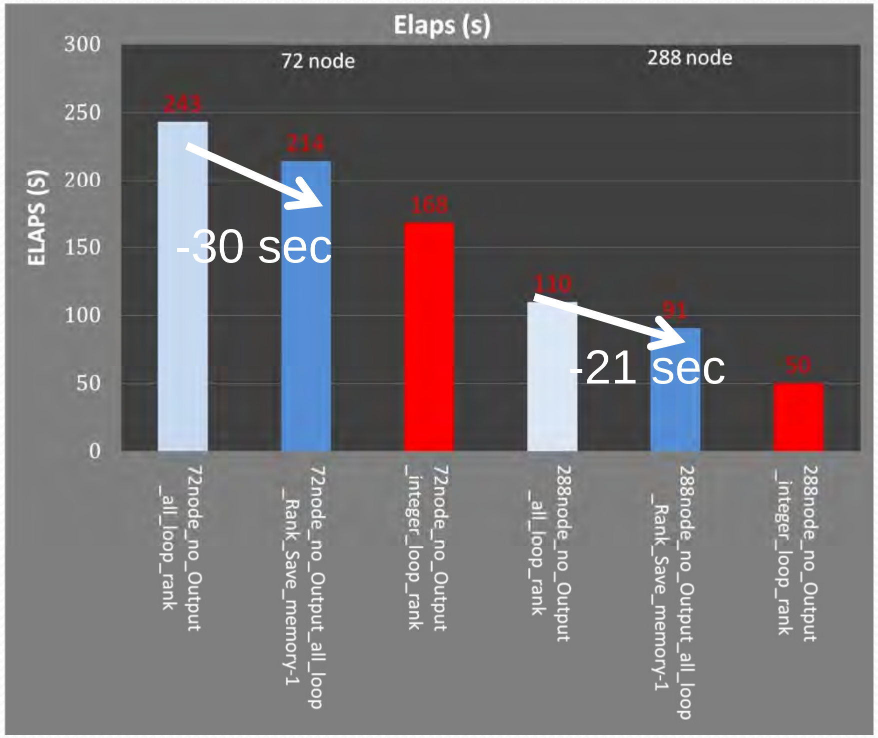

Light blue：No use the dedicated node
Deep blue：Use the dedicated node
Red：Compute physical loop

The computation speed decrease about 20-30 sec using the dedicated node for IO. The elapse of the file output process dominated 12-20% in 72 node case and 35-42% in 288 node case

# Impact of the Save memory

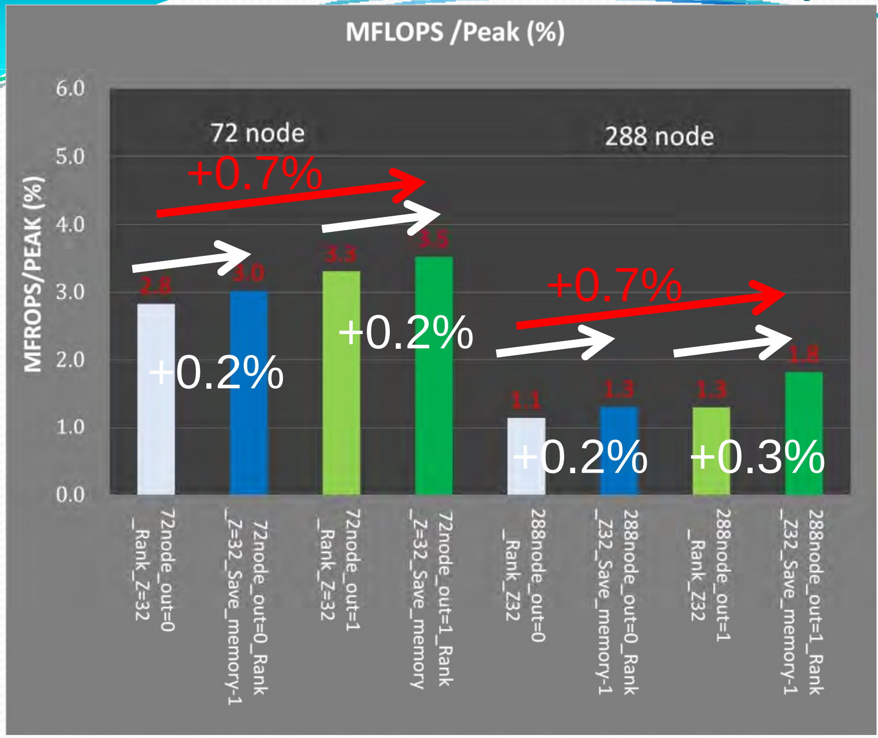
- The Save Memory is a function of the NHM that controls to allocate the variables and the input data on the memory and overhead is reduced.

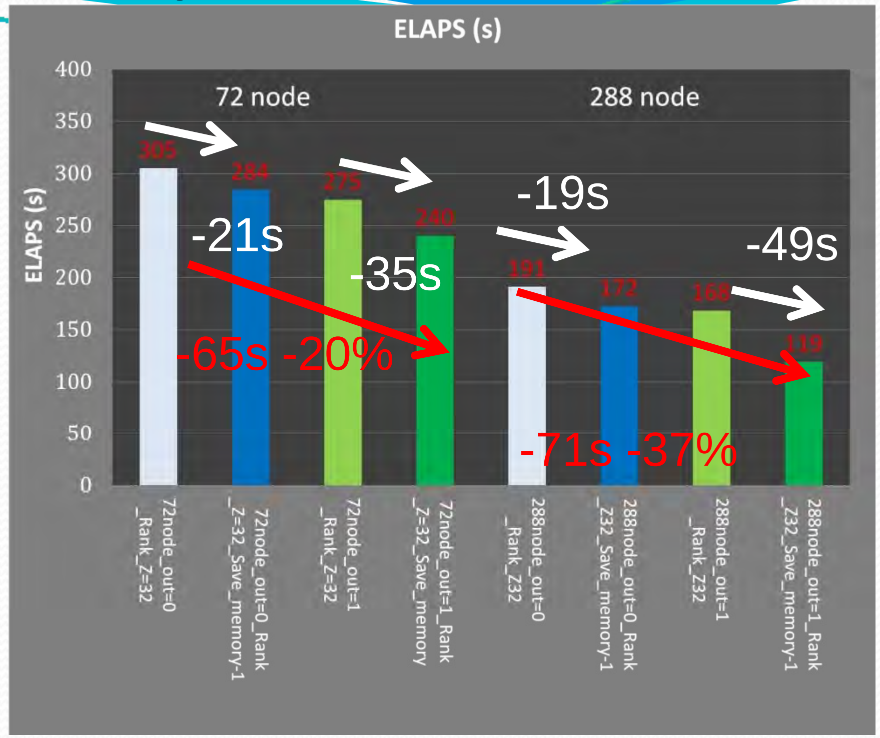


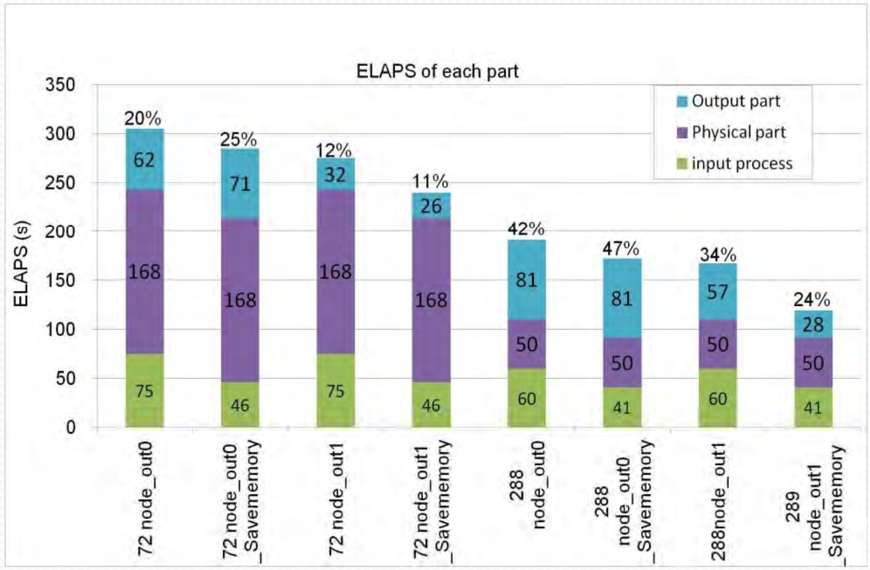




Light green：Output node and no Save Memory
Deep green : Output node and Save Memory
Red：Compute physical loop

# Performance Save Memory and Output node




Light blue：No Output node and no Save Memory
Deep blue: No Output node and Save Memory
Light green：Output node and no Save Memory
Deep green : Output node and Save Memory

The results showed the Save memory reduce the input process, but it also impact to output process.
The result recommends to use both functions are better.

# Conclusion

- The NHM was optimized for the K computer
- The Peak performance increase around  1% in one hour forecast.
- The computation speed is increase maximum 72 second in three hour forecast.
- The Save memory and the dedicated node for output show good result.
- It is recommended to use The Save memory and the dedicated node for output.
- It is expected that the NHM will show good computation performance in the K computer

# Flash flood simulation for several small rivers in Kobe

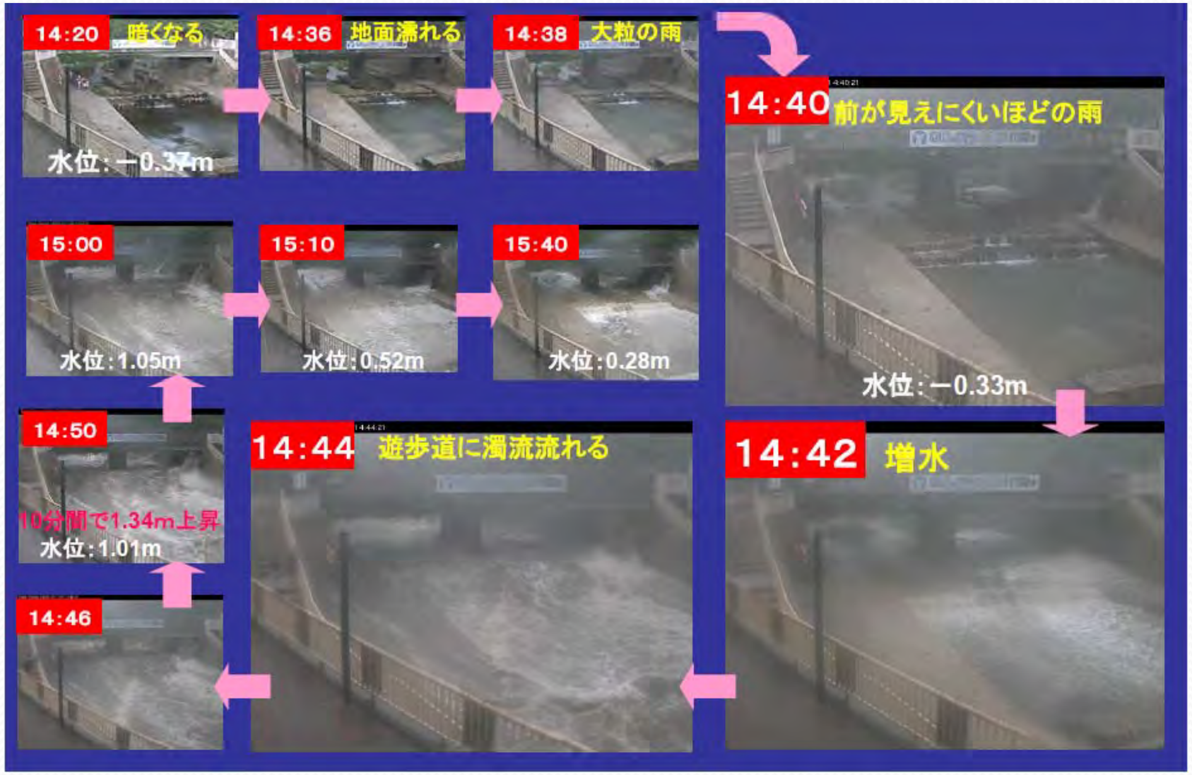
Background

- It is important to develop a hydrological model for a small river flash flood due to the unexpected strong rain.
- Flash floods occur in entire Japan due to topographical condition that there are many very steep, small rivers in urban area.
- To prevent these disasters, prediction system of unexpected rain and real time flood forecast system are necessary.

Why do I select rivers in Kobe？.

- The flash flood disaster impacted entire JAPAN.
- K computer is in Kobe.
- It is easy for me to do field investigation.

# Flash flood in Toga river, Kobe 28 July 2008

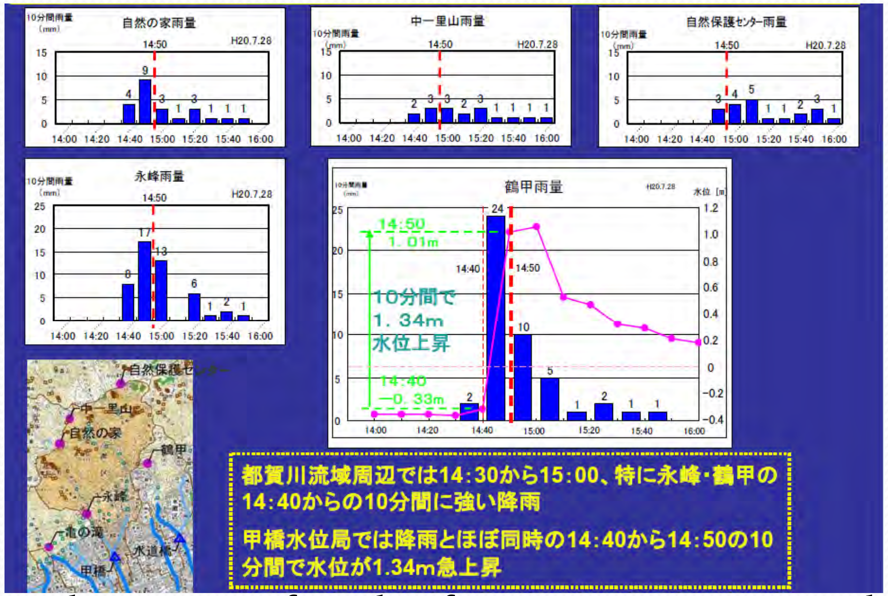



The water level increased 1.34m for 10 minutedue to unexpected rain.
After this disaster, Kobe city has installed automatic early warning system for selected small rivers.
The system uses warning information from the JMA and the information is transmitted by the Kansai Radio's radio wave.

Source: The Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
http://www.cgr.mlit.go.jp/yamaguchi/river/suinan/img/002.pdf

# Objectives of the research

- To improve the hydrological model to urban small river's flood for disaster prevention and mitigation.
- To develop an automatic system which generates initial geodata.
- To develop a real time flood prediction system using predicted unexpected rain.

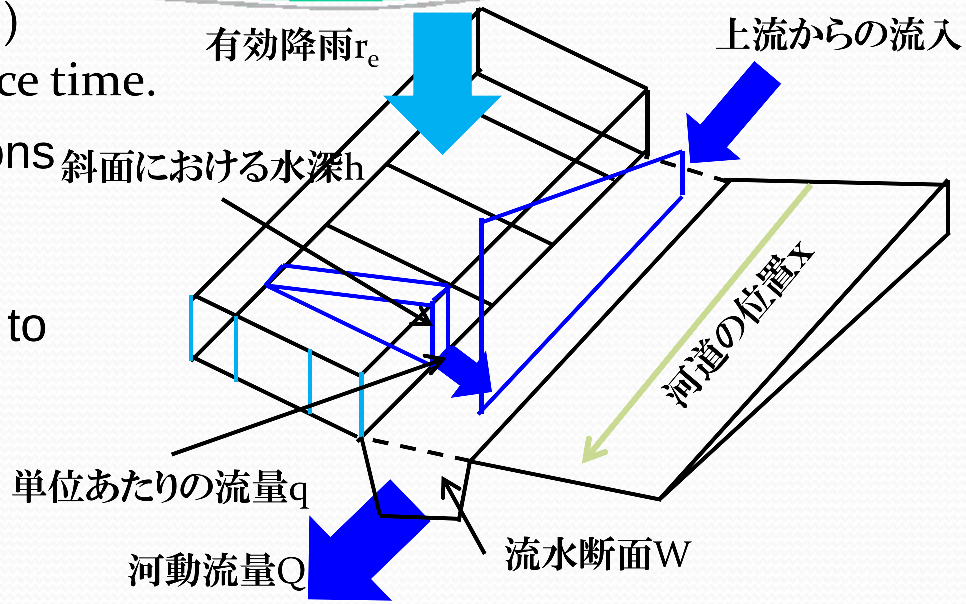


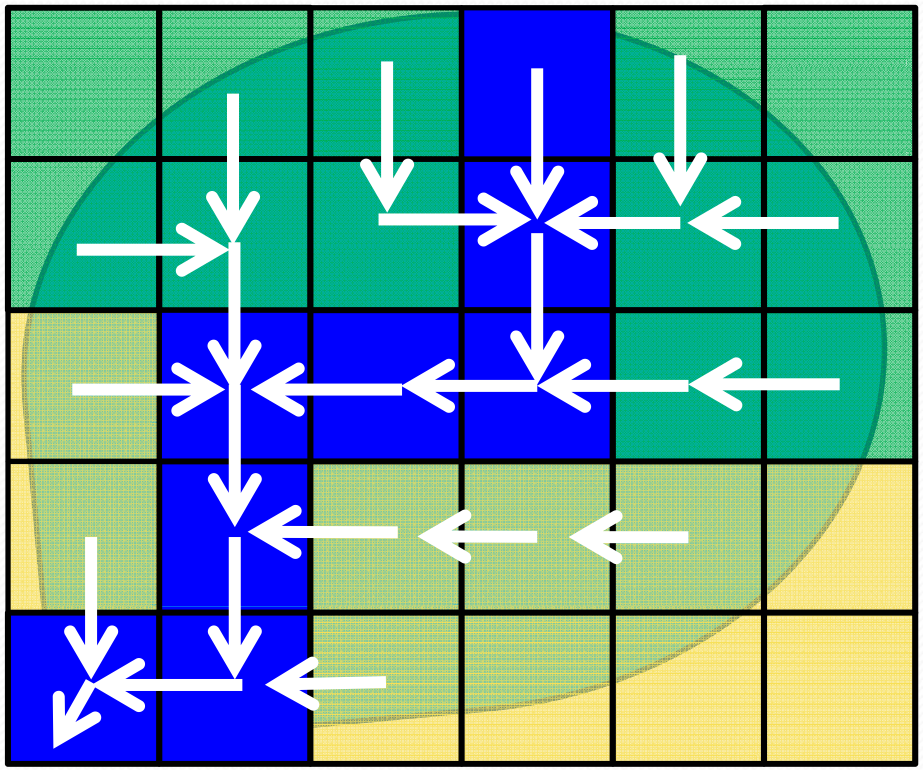

Source: The Ministry of Land, Infrastructure, Transport and Tourism
http://www.cgr.mlit.go.jp/yamaguchi/river/suinan/img/002.pdf

# Cell Distribution Rainfall runoff Model

- The model is developed by Dr. APIP (DPRI)
- The model can calculate several river at once time.

The CDRMV3 uses kinematic wave equations for both subsurface flow and surface flow. Discharge and water depth diffuse to the steepest downward adjacent cell according to a flow direction map generated from DEM data.



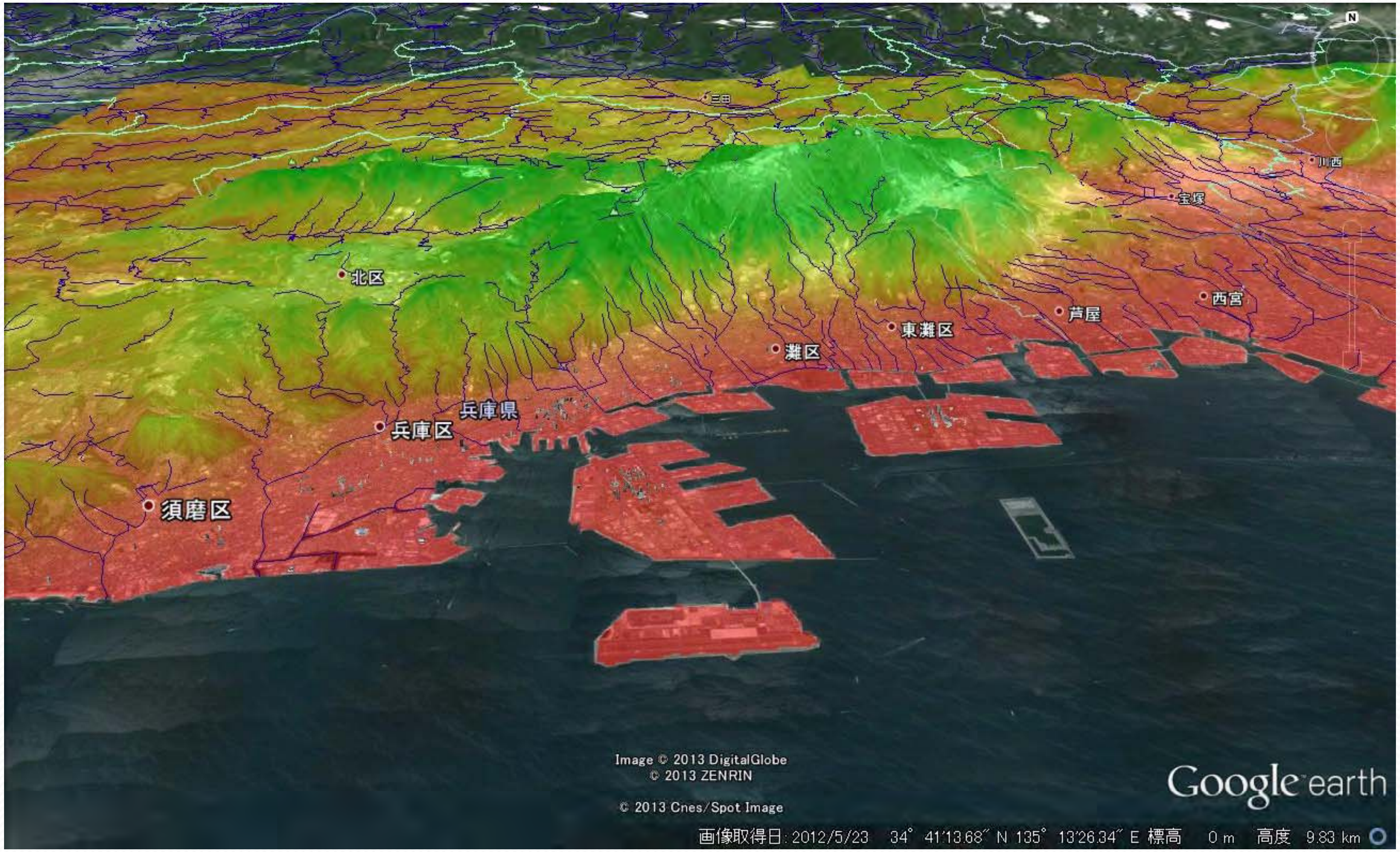
＜斜面流＞

hは水深、qは斜面の単位は単位幅雨量、$r_e$は有効降雨、αとmは定数

＜河道流＞

Wは流水断面、Qは可動流量、qは斜面からの単位幅流入量、G,Mは定数

# Digital elevation map on the google earth

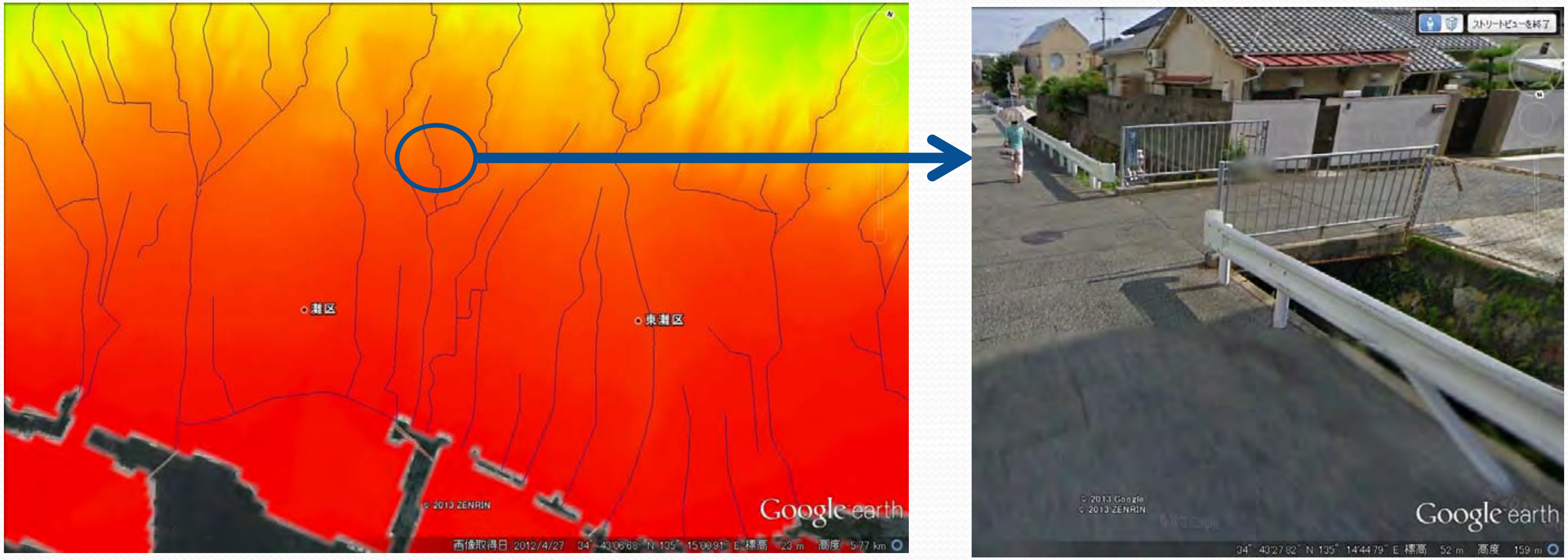



- 15m resolution DEM of KOBE area has already prepared.
- The DEM was generated by the Geographical Survey Institute ‘s 10 m digital data.

# Target rivers and those catchment in Kobe city


- Five rivers are selected for the research.
- Network cameras monitor those rivers.
- The red colored river's name observe water level

# Data quality check



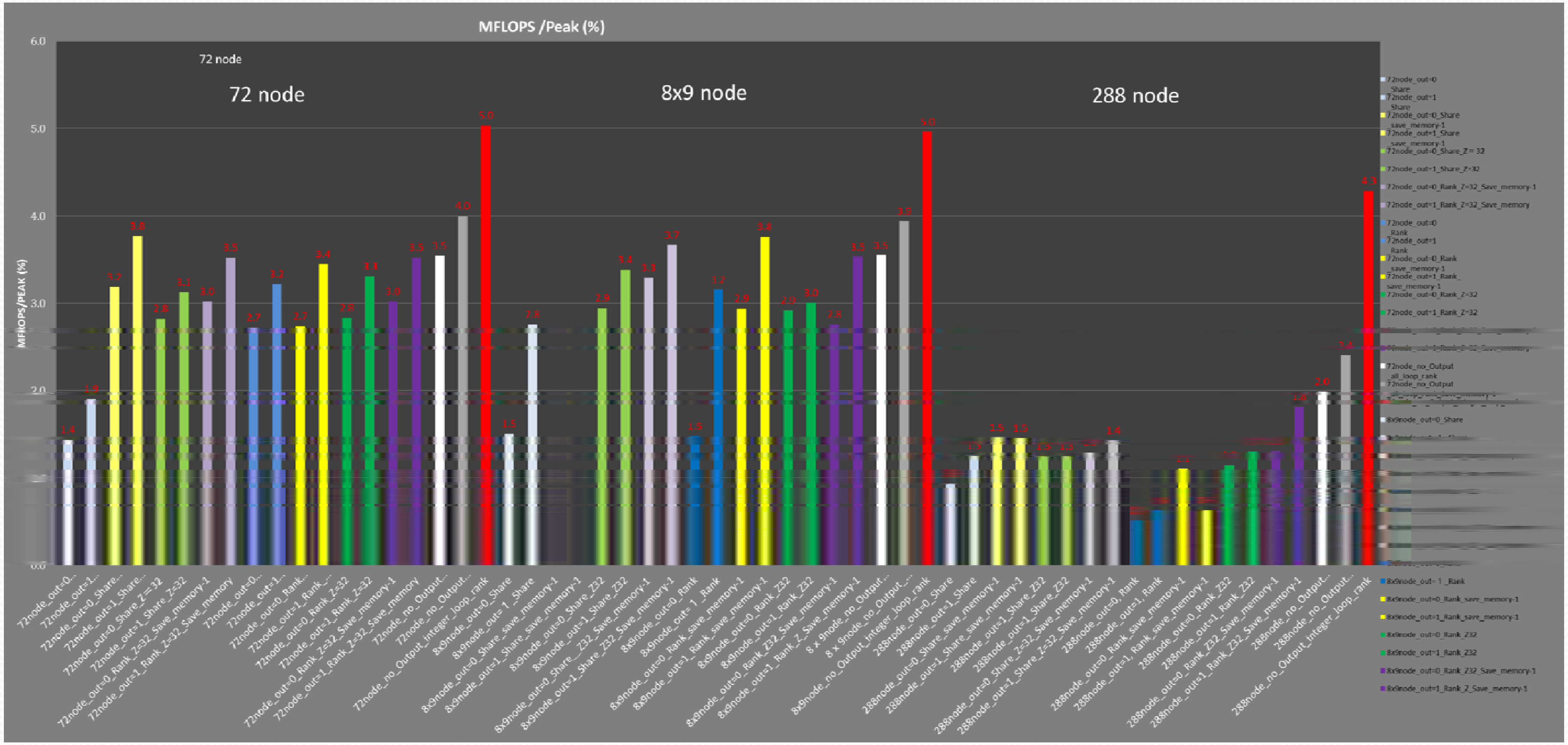

- Digital data of river and real river are different.
- Some rivers of digital data are culvert.
- A field investigation and data quality check are very important for small river research.

# Future work

- We will test the model in the Kobe rivers.
- The model was developed for the mountain slope flow.
- I will improve the urban area part of the model.
- The model will use output of the NHM on the K computer.

ご静聴有難うございました

# All results of the Peak performance



# All results of the Elaps