

# Development of web-based services for an ensemble flood forecasting and risk assessment system

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"The latest HPC technology combined with detailed terrain data achieves better understanding of flood risk for specific end-users"

<http://NEWS.nmpi.net>

## Development of web-based services

Flooding is a wide spread and devastating natural disaster across the globe. It is the worst natural disaster in the UK. Annual flood damage in the UK is about £1.5 billion and expected to increase to £3.5 billion over the next few years (Association of British Insurers). Floods that took place in the last decade in China were ranked the worst among recorded floods worldwide in terms of the number of human fatalities and economic losses (Munich Re-Insurance). Against this background, the establishment of effective flood event forecasting and risk analysis systems has become a priority, especially in many flood prone countries including China and the UK. The latest High Performance Computing (HPC) technology combined with detailed terrain data achieves better understanding of flood risk for specific end-users. Web-based interactive geographical interfaces offer an intuitive way of accessing, mining, and visualizing spatial maps. We present the development of web-based services for the Novel Early flood Warning System (NEWS). Two pilot sites were selected in this study: (1) the Upper Severn, a meso-scale catchment (ca. 4062 km<sup>2</sup>) located in the Midlands region of England; (2) the Upper Huai catchment (ca. 30672 km<sup>2</sup>) located upstream of the Huai River which is mid-way between the Yellow and Yangtze Rivers. TIGGE ensemble forecasts from a number of meteorological centres with 10-day lead time were extracted and disaggregated to drive the hydrological models to forecast discharges. The meteorological data, hydrological data and other required data are physically located in different places, so are the processing algorithms and models. A web-based platform based on Grid middleware is used to solve problems related to spatial and temporal distribution of data and algorithms. An attempt is made to produce end-user specific forecasts. The network layout and schematic flowchart of the NEWS prototype together with website screenshots is presented in this poster. NEWS is expected to satisfy the unmet technological demands in the field of flood prediction and risk analysis. Such interactive web-based services will bring significant benefits and commercial value to both private and public sectors.

## Schematic flowchart and network layout

The NEWS platform unlike current flood forecasting system is able to: (1) incorporate multiple weather forecasts and post-forecast data processing into one system to achieve reliable flood warning (2) assess uncertainty and risk of an ensemble forecasts (3) Provide API Web services with interactive flood risk mapping (4) make use of advances in HPC environments. NEWS provides web-based services to a broad spectrum of end-users in different geographical locations. Figure 1 illustrates the NEWS schematic flowchart starting with the THORPEX Interactive Grand Global Ensemble (TIGGE) archive. The TIGGE data archive provides meteorological (Meteo) forecasts for the NEWS system. The Meteo data will be retrieved from one of three data portals (ECMWF, NCAR or CMA portals). The raw Meteo data needs to be pre-processed. This usually involves a downscaling or interpolation procedure to meet the required data format and resolution of the hydrologic and hydraulic models (Hydro tools). A correction procedure will be performed depending on the skills of the raw forecasts, which will be evaluated using various scores. The Hydrol tools require a model initialisation using the observed precipitation (Pobs) and temperature (Tobs). The flowchart is more elaborated on the webpage (<http://news.nmpi.net/download/flowchart.htm>). The flowchart is the basis or the so called back-end of the NEWS web-based services. To realise such a flowchart in a real-time forecasting environment presents challenges including (1) databases and codes that reside in different locations and converge at different times and (2) data protection and security issues. To overcome this hurdle the Grid middleware product UNICORE is used (please refer to Figure 2 and Figure 3). UNICORE is a ready-to-run system that makes distributed computing and data resources available seamlessly and provides robust interoperability through strong security and workflow.

## Development outlook

(1) How far can we model & visualize flooding? - global, national, regional, local, microscale? (2) Uncertainty visualization in hazards maps; (3) Visualizing uncertainty for sector specific risk managers; (4) Uncertainty representation of point and linear data; (4) Multimedia Atlas Information Systems (MAIS).

## NEWS项目中文背景概述

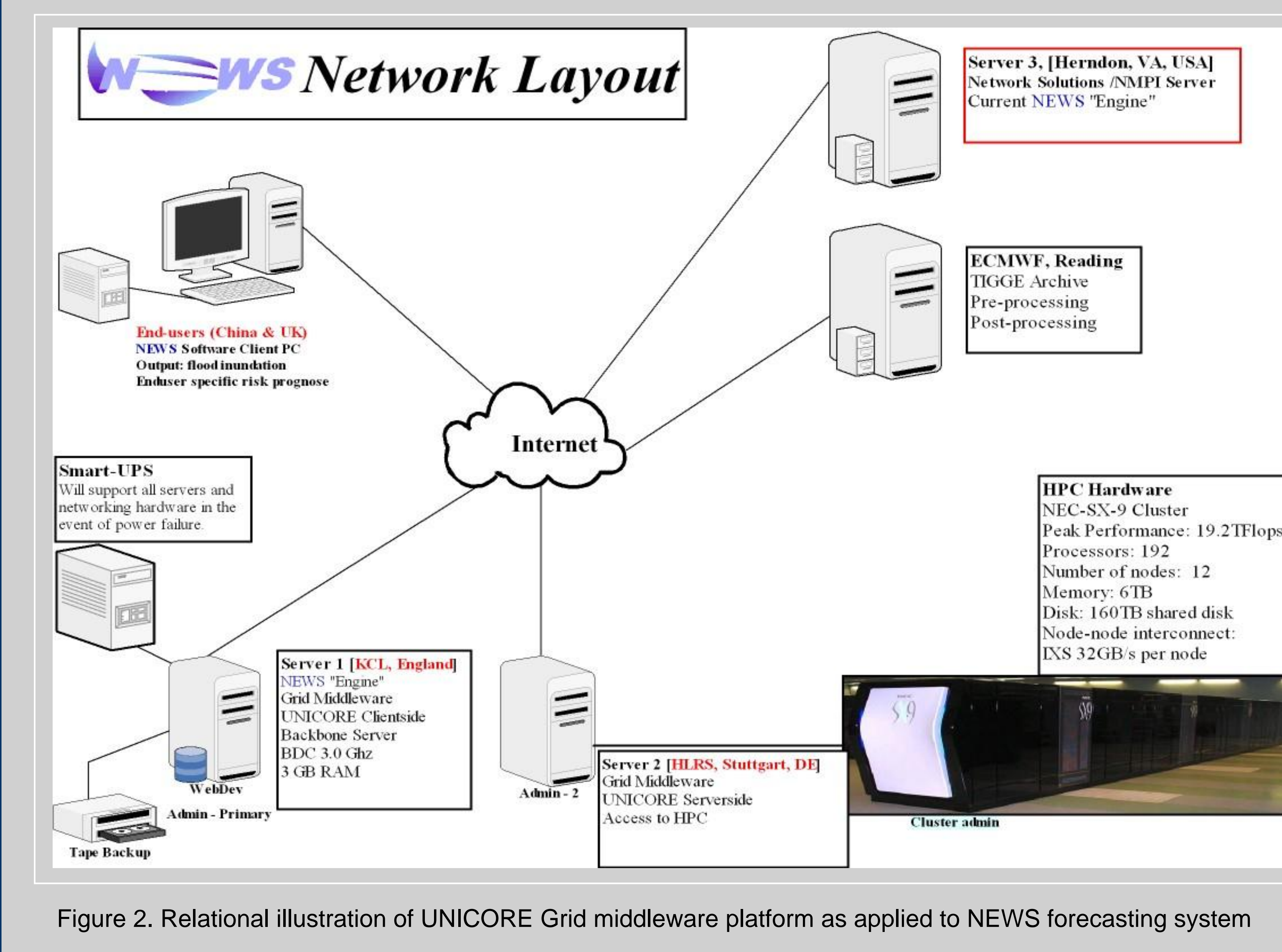
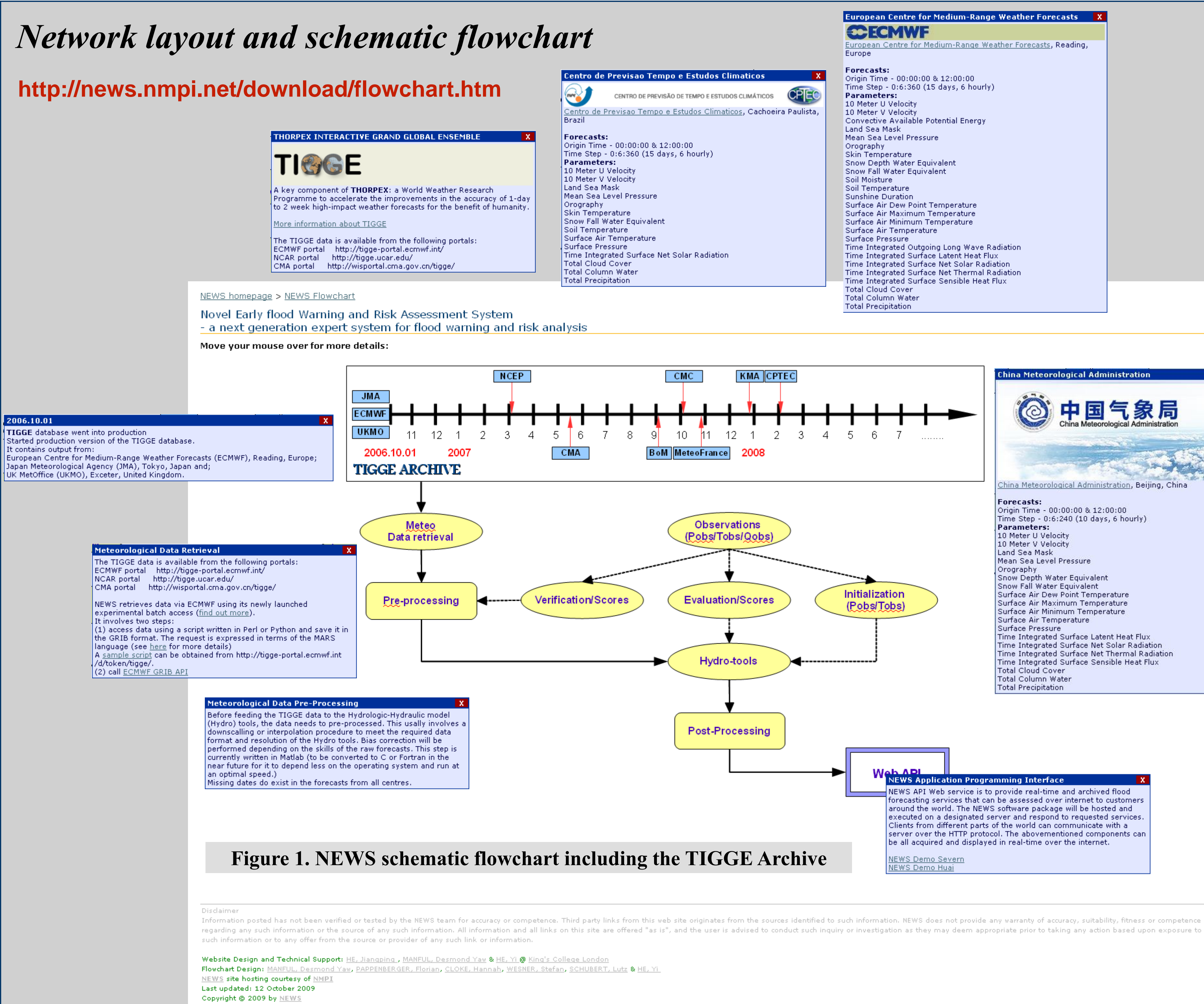
集合预报系统从其本质上讲又可称之为概率预报系统，其最终目的是提供大气变量的完全概率预报。近几年集合预报技术经历了不断的发展完善，从以前仅考虑初值的不确定性发展为同时考虑模式的不确定性，进而发展到多模式和多分析集合预报技术。TIGGE集合预报是世界气象组织的“观测系统研究和预报实验”项目的重要组成部分，在全球范围组织各气象业务中心的集合预报开发与合作，并计划发展成为未来的“全球交互式预报系统”。该技术在世界范围被认同，并逐渐成为天气预报的主流发展趋势。NEWS“中小尺度集合洪水预报系统”：(1) 引入尺度转化方法，加强该项技术用于到小尺度流域的可行性；(2) 完整的气象、水文和水力模型耦合，一套系统可以连续运行提供流域范围内降雨量，洪水过程线和洪水淹没区域及水深预报；(3) 对统计预报的后续处理和预报修正；(4) 预报洪水统计风险区域图。NEWS已经在英国中部塞文河 (Severn river) 流域上游子流域进行了试验洪水预报(水文预报为1公里网格精度，水力预报为50米网格精度)。与传统预报技术相比，其预报准确性和命中率显著提高，虚警率降低。从时间上讲，洪水过程预报可以提前至3到10天，从而为疏散居民和转移物资提供了宝贵的时间。

NEWS中小尺度集合洪水预报系统现由海河大学和伦敦国王学院在淮河流域共同试验开发，英国合乐集团 (Halcrow) 受聘进行市场调研。NEWS项目同时得到了安徽省水文局和欧洲中期天气预报中心 (ECMWF) 的大力支持。

尽管集合概率预报结果与传统方法比较有显著提高，但其发布还需要做大量的普及推广和培训工作。目前伦敦国王学院在塞文河流域的试点项目是世界范围内第一次将TIGGE多模式集合气象预报与分布式水文水力模型耦合应用，其推广前景还需要在不同流域范围内，不同气候条件的区域进行试验，以便确定其应用技术的普遍性。中国在面向TIGGE的集合预报关键技术已经做了大量工作，为水文水力领域中应用该技术做好了准备工作。

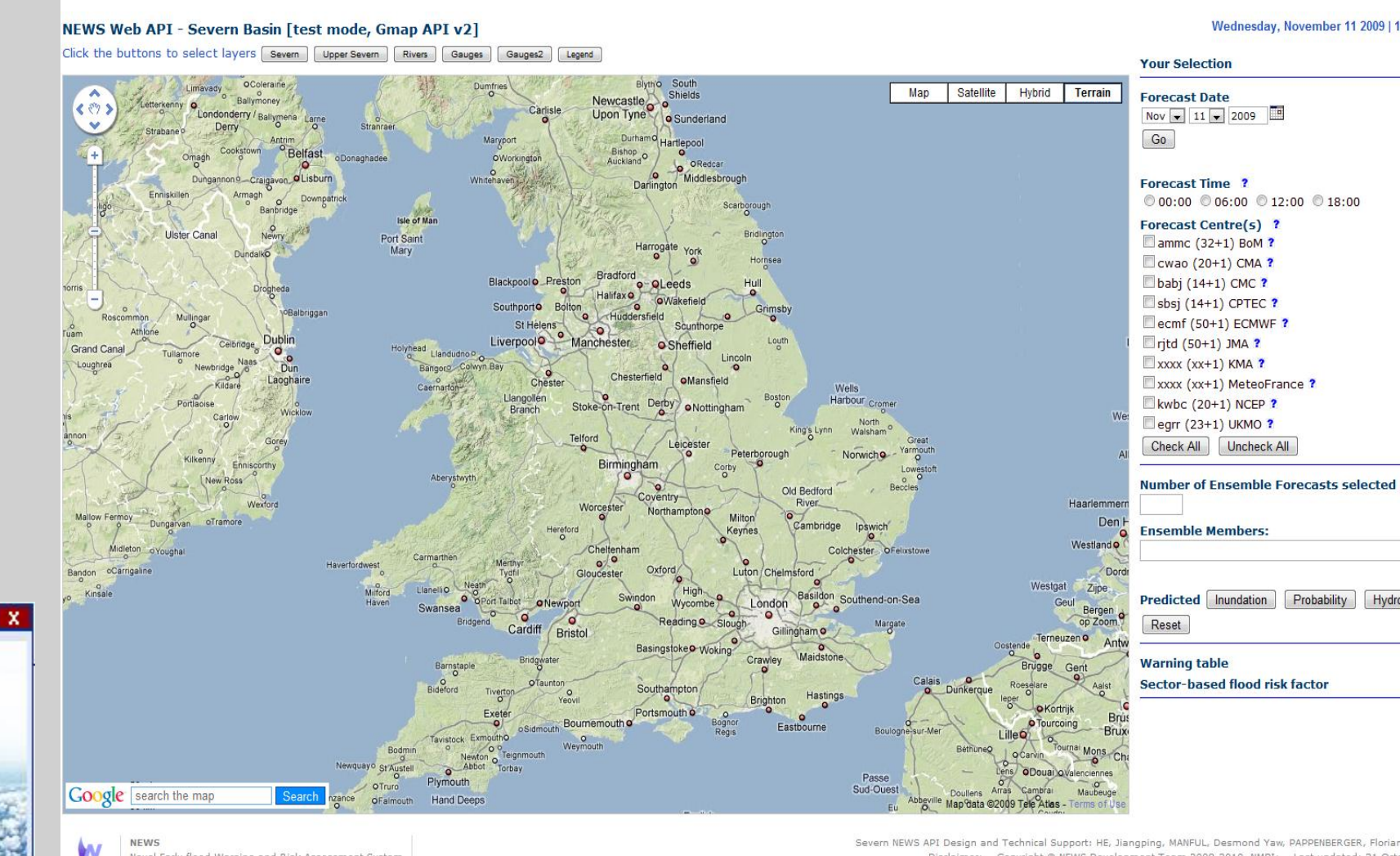
## Network layout and schematic flowchart

<http://news.nmpi.net/download/flowchart.htm>



## Screenshot 1: second generation NEWS Software – Web-based Service Platform – Severn River Catchment

Front-end API: Basic prototype - without Risk interpolator \ Configurable End-user Settings  
Back-end: Basic prototype - without Grid-middleware infrastructure and Covis Visuals

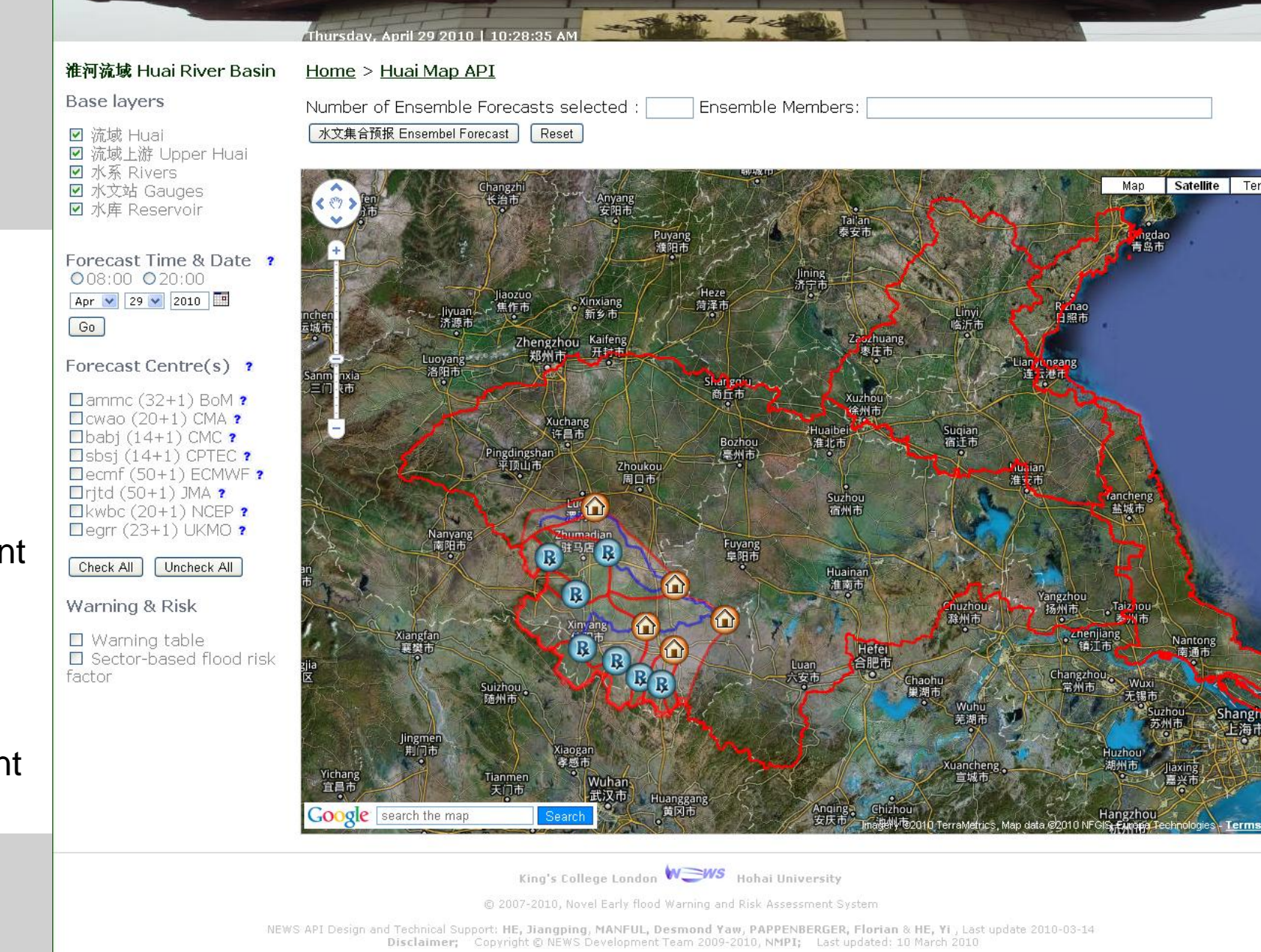


## Screenshot 2: second generation NEWS Software – Web-based Service Platform – Severn River Catchment

Prototype: Event Simulation 1 /Severn River near Monkmoor Wastewater Treatment Works



## Welcome to Huai River



## Screenshot 3: second generation NEWS Software – Web-based Service Platform – Huai Catchment

Front-end API Webpage with selection of various catchment features such as rivers (blue line), hydrologic stations (R symbol in a circle with blue background), reservoirs (a house symbol) and catchment boundaries (red line).

