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# What Had Experienced Scientifically the Experimental Basins of China During the Last 50 Years

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The development of the experimental and representative basins (ERBs) of China within last five decades shows a saddle-backed fluctuation with two peaks which reflect the story and the trying experiences of the Chinese basin study itself. The two peaks, about 1958 and 1983, were stimulated by the active social demands of water engineering and water resources problems respectively. However, both the ‘‘cultural revolution storms” around 1966 and the ‘‘market-economy tide” around 1990 substantially reduced basin research efforts. This was in spite of the fact that basin studies had contributed greatly to engineering hydrology and water resources evaluation. Since 1980s, trying was made for the scale problems of EBs and a so-called hydrological experimental system with the core of EBs was established as the Chuzhou Hydrology Laboratory, flow tracing using environmental isotopes and inorganic ions was also initiated in cooperation with USGS and, had learning much from the \textit{Euromediterranean} \textit{Network of Experimental and Representative Basins}. It is concluded from the results that to make improvement for the situation of hydrology which is as yet lacking a solid scientific foundation needed for its development as a natural science (Klemes,1986), the hydrological experimentation appears the unique way to make sound of its scientific base and, ‘‘to drain the swamps” as what Klemes described that hydrological misconceptions may be similar to mosquitoes, it may be necessary to drain the swamps rather than merely continue killing individuals.

\textit{1 The misleading design concept for the experimental basins (EB)}

The design strategy for the EB network, the individual EB, the hydrological factors to be observed/monitored and, its methods to be used over its first three decades were based mainly on the classical conceptions of rainfall-runoff processes and hydrograph components. The main problems resulted are the following.

\begin{itemize} \item Most work did not treat the basin as a whole system, from its bedrock to the air, viewed both qualitatively and quantitatively. Instead it concentrated mostly on surface hydrology and particularly on water quantity. For example, little attention was paid to the subsurface behaviour of the basin's water cycle. \item The monitoring factors or sometimes the monitoring strategy was incomplete or incorrect, or was insufficient to reveal the components of the 'black box'. For those basins aimed at an empirical solution only, no reference basins (benchmark basins) were available or the comparability of paired basins was not be demonstrated. \item The measurements of the various components of the water balance could not match the requirements of the EB's original purposes. Either they could not deal with the spatial variability within the basin or, they could not get the necessary accuracy because of poor monitoring methods. \end{itemize} It then moved into an odd loop i.e., according to Chinese sayings, to have an expectation for fine wheat flower from a rock mill. The tragedy was, the master who offers the mill always complained of the operation hydrologists' misconduct without fine flower even they had worked so hardly sometimes without enough foods. It also resulted in the despite and cancellation of EBs.

\textit{2 Hydrological Experimental System (HES) with the core of EBs}

An attempt for the scale problems happened and for the rationalization of strategic ideas was made for the new established Chuzhou Hydology Laboratory (CHL) since 1980. Hydrological experimentation aimed at quantifying hydrological phenomena and hydrological process, however, it seems impossible to take the hydrological system as a whole into a laboratory for experimental research as most other sciences did. Currently there are two ways to treat it. First, take a piece out from the complex real hydrological process, and isolate it from surrounding environment, only few related parameters are controlled for research, e.g., some kind of hydrological physical models, laboratory catchment without soil layer or with a monolith only. It is so-called the way of ‘‘isolation” or ‘‘purification”. It appears useful but it seems idealized from the natural process. Secondly, as most RBs and EBs did, the boundary conditions of catchments used for study keep natural, only few of it can be controlled e.g., the vegetation coverage. And, the discharge from the catchment to be measured is the total runoff only. It is the way of ‘‘black box”. It appears rather useful for e.g., engineering hydrology but only empirical results can be obtained, i.e., the results can only be treated statistically or by correlation. It really can't make any advance in understanding the hydrological mechanism. A circular concept is then suggested as the hydrological experimental system to fit in the complexity of experimental hydrology. It is considered from the natural ‘‘synthesis” condition to a condition of controlled parameters and then isolation of a process as e.g., the laboratory catchment. Next again goes to a control condition in a more complex manner and subsequent testing to the natural condition and further research on a large scale. The HES includes the natural RBs, EBs, laboratory catchments, lysimeters, and, an intermediate research catchment (SB) which is suggested and designed to be intermediate between the complexities of natural watersheds and the idealities of monoliths. The SB, so-called simulated experimental basin, is 'real' or natural in sense with soil layers and vegetation in the shape of natural watershed, it is however also artificial with controlled boundary conditions including a concrete aquiclude and a built-in drainage system with all the runoff responses including both the surface and subsurface components being directly measured and sampled.

\textit{3 Water tracing using isotopes and inorganic ions}

Environmental isotopes $^{18}$O, D, T and various inorganic ions were used for flow tracing in RB, EB and SB aimed at hydrological fundamentals. The results get from the HES in CHL challenge the traditional conceptions widely used in this country. They mainly are the following.

\begin{enumerate} \item[\textbullet] Identification of surface runoff and two subsurface runoff components and, the pre-event water composition in various runoff components including that in the surface runoff. \item[\textbullet] Several misconceptions related to the rainfall-runoff relationship including that of the hydrograph used for hydrological analyses. \item[\textbullet] Eleven patterns of runoff generation in addition to the base flow have been identified, it includes 4 types of surface flow, 4 types of interflow and 3 types of groundwater flow. The requirements of various kind of runoff generation are identified individually. \item[\textbullet] Eight suggestions for the current two-components isotopic separation are evaluated, it follows that it seems unreasonable for natural basins. \item[\textbullet] The temporal and spatial distribution of hydrological parameters in a basin including that of environmental isotopes and inorganic ions, it is varied sometimes significantly within an event precipitation, within runoff components and even in the saturated zone. \item \textit{Conclusions } \end{enumerate} Hydrological experimentation seems the unique way to make sound of the scientific base for hydrology. It follows that Experimental Hydrology is now taking shape in scientific hydrology with its own task, method and theory (Gu 1983, 1987).