

## ***Interactive comment on “Hydrology and Water Resources Management in Ancient India” by Pushendra Kumar Singh et al.***

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I read with interest the contribution *Hydrology and water resources management in ancient India* by Singh et al., in which, on the basis of an accurate bibliographical review, the Authors present many aspects of the multifaceted hydrological and hydraulic knowledge in ancient India. The themes addressed are the comprehension of the hydrological cycle, the precipitation measurements, the water management (with more evidence to the hydraulic structures than to the management practices) and the wastewater management.

The paper is well written and thoroughly argued, and it makes a state of the art of the matter, provided that the topic stands between many disciplines (history, archaeol-

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ogy, hydraulic engineering, history of technology and history of culture). Therefore the paper might be eventually recommended for publication, but I encourage the Authors to strengthen its unitary perspective, in order to depict a wide portrayal, thus avoiding the risk of giving the idea of a collection of cases.

As a first point, for example, it might be useful to explicitly state both in the Abstract and in the Introduction which are the geographical and historical boundaries of the matters, and possibly why these boundaries were chosen, and the aims and the methods of the research.

Many informations presented in the Introduction might be effectively contextualized in the following sections, whereas in the Introduction it is recommended to declare which is the order along which the matter is presented in each section (e.g. historical order, or process– or technology–based order, etc.).

Also the concept of “hydraulic civilization”, which is sometimes used in the paper, might be better defined in the Introduction. In fact in all the ancient and modern societies the water management plays a crucial role, but the attribute of “hydraulic civilization” is nowadays preferably used to identify those civilizations which survival was deeply linked with the capability of managing the water–related issues (as e.g. the water scarcity, the soil salinization, or the floods) and, in most of the cases, the management was centralized via well structured groups of technicians and skilled workers (as it was e.g. the case of the great Central Asia oases).

Finally I encourage the Authors to enlighten, on the basis of the investigated literature, the links between the Indian hydraulic culture and that of the surrounding cultures, particularly regarding the water technologies (see below for details).

As a general typographical aspect, I recommend to check and uniform all the emphases and the citations, and to add a complete English translation to all the book titles (the first time they are introduced) and to all the ancient citations.

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In the following I list some detailed notes:

**line 49** add a reference for the citation;

**1.53** emphasize *variyantra* and better detail its functioning;

**1.57** *pynes* and *ahars* are very interesting structures, also in this case I recommend to better define their functioning (e.g. whether *ahars* are fed by *pynes* or by the slopes) and, if possible, their diffusion;

**1.73** it is meant the *Arthashastra* of 1.50, isn't it?

**1.115** *it can be inferred...*: this is an important point for the comprehension of the hydrological cycle.

Since what it is reported, it seems that the correct comprehension of the hydrological cycle was already achieved in ancient India, as it was few centuries later in ancient Greece, before the Aristotelian statement according to which the water of great rivers could not be stored inside the Earth. Are there explicit references to issues related to the infiltration and to the storage in subsoil reservoirs?

This conjecture (the Aristotelian one) paved the way to an (incorrect) description of the hydrological cycle based on the concurrence of two cycles: one external to the Earth, driven by the Sun, and a more important one internal to the Earth, driven by an engine placed within the Earth's depths. At Authors' knowledge, are there reflections of this conjecture in the Indian late–antiquity hydrological culture?

Moreover *Puranas* are reported to be written between 600 B.C. and 700 A.D.: is it possible to provide a closer time range for the ones which are cited by the Authors (and particularly for the *Vayu Purana*)?

- I.125** Do ancient texts use the word *smoke* instead of *vapour*? It might be interesting, as in the Aristotelian tradition *smoke* is used for the dry air in opposition to *vapour* which is used for the moist one;
- I.132** Add an English translation (as well for the other citations and titles, see before in the general comment);
- II.162—163** It is a very interesting point, as the *veins* metaphore was common also in other contexts (see e.g. Leonard from Vinci). What feeds such veins, as it is reported by *Brihat Samhita*? And which is the direction along which do they flow?
- II.216—217** Probably not necessary;
- I.223** Kautilya. . . : add a reference;
- I.231** It seems an astronomical approach, rather than an empiristic one: were there found evidences for multiannual precipitation cycles?
- I.242** Please, check whether *capillary* is properly used;
- I.257** In which sense it is used *change in the direction of flow of groundwater*?
- I.260** Artesian wells seems not been introduced before, a reference will be useful;
- I.267** In which sense are introduced Eastern and Western emispheres?
- II.281—282** It seems more a *saqiya* than a *naoor / noria*: could the Authors add few details?
- I.285 and followings** Probably it is not necessary to enter here the debate on the origin of the *noria*, or it is better to strengthen the cited references base on this topic;
- I.336** In which sense *low cost* is used?

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- 1.340 and followings** *Rabi* irrigation was a spate irrigation, a basin irrigation, or a furrows irrigation?
- 1.364** ... *an act of religious merit*: it is very interesting to unveil the cultural link between the humans and the Nature. Could the Authors better detail in which sense building reservoirs was considered a religious merit?
- 1.379** These dams seems more *barrages*, eventually used also for spate irrigation. Could the Authors add some more details on the discharge regime and on the use of these dams? Is it a *wadi* regime?
- 1.381** Is the return period referred to present climate or it was estimated for the ancient one?
- II.434—440** Probably not necessary here, and more useful in the Introduction;
- 1.447** *tapered terra-cotta pipes*: Could the Authors add some details on these pipes? They seem frustum-of-cone shaped *fistulae* common in the Central Asia oases and Latin world;
- II.463—465** It sounds not very clear, probably not necessary.

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