Varāhamihira, the earliest hydrologist

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ABSTRACT Varāhamihira (AD 505-587) was a versatile personality. He was an astrologer, an astronomer, and a hydrologist. In his magnun opus, Brihat Samhita, he deals with all these subjects and discusses exploration for groundwater with the help of plants. There are separate chapters in this work for cloud formation, signs of immediate rain, quantity of rainfall and the role of asterisms.

RESUME Varāhamihira (505-587) était une personnalité aux talents variés. C'était un astrologue, un astronome et un hydrologue. Dans son grand ouvrage Brihat Samhita il traite de toutes ces sciences et discute de la recherche des eaux souterraines avec l'aide des plantes. Il y a dans cet ouvrage des chapitres séparés pour la formation des nuages, les signes annonçant une pluie immédiate, les quantités d'eau précipitées et le rôle des astérismes.

INTRODUCTION

Varāhamihira belongs to the galaxy of Indian scientists that include Dhanvantari, Caraka, Susruta, Āryabhaṭa and Bhāskarācharya whose fields of specialization ranged from medicine and surgery to mathematics. In the long history of Bhāratiya Jyotiṣa (Indian Astrology), Varāhamihira stands supreme as a versatile personality. His greatest work, Brihat Samhita, deals with an astonishing variety of subjects of exceptional interest and value. Alberuni, the Arabian astronomer who translated the Laghu Jataka of Varāhamihira into Arabic, eulogizes the Brihat Samhita for its richness in details. Astronomy, architecture, sculpture, medicine, psychology, physiology, botany, zoology, groundwater and other subjects are treated in a masterly fashion and the language and style used prove Varāhamihira to be a poet of high order in Sanskrit. He had a great admiration for Kālidāsa. A later tradition includes them among the nine jewels of Vikramāditya's court, but their contemporaneity has been disproved (Sarma, 1981).

Varāhamihira (AD 505-587) belonged to Avanti (Ujjain) and studied Jyotisa (astrology) from his father, Ādityadāsa. Both father and son were worshippers of the sun. Āryabhaṭa, the celebrated astronomer was older than Varāhamihira but the two met frequently at Kusumapura in Magadhadesa. An intellectual with a broad outlook, Varāhamihira who respected learning wherever it was found, was intimately acquainted with the astrological literature of the Greeks
to which he makes a reference in his works, but he was not a blind follower of old ideas. Some of his works are *Panchasiddhāntika*, *Vivāhapāṭala*, *Brihajjātaka*, *Laghujātaka*, *Yātrā* and *Brihat Samhita* possibly written in that order.

**BRIHAT SAMHITA**

The *Brihat Samhita*, a work on the Samhitā (i.e. a collection) branch, consists of 106 chapters with a total of nearly 4000 slokas (verses). It deals with a large range of subjects, including the movements of planets and their influence on human life, geography, architecture, iconography, omens, manufacture of cosmetics, botany, precious stones and so on. Encyclopaedic in character, the *Brihat Samhita* must have been of immense use to people, particularly to the kings of ancient India, providing guidance in their daily life in respect of many things. It shows the range and wide sweep of Varāhamihira's mind. One can get a very good idea of the India of his times from a study of the *Brihat Samhita* (Shastri, 1969).

**On the formation of clouds**

In chapter XXI entitled "Garbhalakshanam" (formation of clouds), Varāhamihira gives the properties of the rainy season and relates the movement of planets through stars/constellations to the formation of clouds. Sloka 5 says that the conditions leading to the formation of clouds (pregnancy) are to be detected when the Moon transits Pūrvāshādhā commencing from the first day of Margasira. Sloka 6 indicates that the foetus formed during a particular phase of the Moon will be born 195 (solar) days hence, the Moon then standing again in the same phase according to the lunar calendar. In slokas 9-12 it is pointed out that the clouds formed in the first half of Chaitra (March-April) will yield water in the latter half of Aswayuja (October) and those that are formed in the latter half of Chaitra will rain in the first half of Kartika (November). Sloka 13 affirms that the clouds formed in the east will give water in the west and vice versa. The same rule holds good, according to the sloka, in the case of the other pairs of directions and, in like manner, the winds too reverse during the two periods. These concepts seem to have been in vogue during the Rgveda period too (JRAS, 1871). Some of the auspicious characteristics for nourishing rain-foetuses are: pleasant, soft, northerly, northeasterly or easterly winds; clear sky; moon and sky covered by a glossy, bright and thick halo; an overcast sky with large dense, smooth needle-like or razor-shaped red, black or blue clouds and a bright moon and other stars (slokas 14-18). Clouds resembling pearls or silver or having the complexion of tobacco, lotus or collyrium and of the shape of aquatic animals foretell profuse rain (slokas 22-24). Varāhamihira also enumerates the signs indicating miscarriage of rain-embryos and destroying all chances of rain: fall of meteors, lightning, dust-storm, burning of the quarters, earthquake, etc. (slokas 25-26). He also mentions that the cloud-foetuses formed in any of the six months from Mārgasīrsha to Vaṣākha (December to May) when the moon enters any of the five asterisms,
viz. Pûrva- and Uttara-Bhādrapadā, Pûrva- and Uttarā-shādhā and Rohinī give profuse rain. The foetuses formed in Mārgasīrṣa (November-December) cause rain for eight days; those in Pauṣa (December-January) for six days; those in Māγha (January-February) for 16 days; those in Phālguna (February-March) for 24 days; those in Vaisākha (April-May) cause rain to fall for three days only (sloka 20). A rain-embryo accompanied by all the five concomitants, viz. wind, water, lightning, thunder and cloud will produce profuse rain over an expanse of 100 yojanas; that accompanied by four phenomena over 50 yojanas; that having only three phenomena rains over an area of 25 yojanas; one accompanied by two over 12 yojanas and a half; and that by only one will cause rain to fall over five yojanas (sloka 31). According to Kauṭilya, a forecast of rainfall could be made by observing the position of Jupiter and its motion, the rise and setting of and motion of Venus, and the natural or unnatural aspect of the sun (Kauṭilya).

On the quantity of rainfall

Raingauging appears to have been prevalent in India from very early times and the earliest reference to it is to be found in Panini's Astādhyāyī. According to Varāhamihira, rain should be measured after the full-moon day of the month of Jyeṣṭha (May-June) when it has rained in the phase of the moon commencing with Pūrvāṣādhā (sloka 1). In Varāhamihira's time, the commonest measures of rainfall were pala, ādhaka and droṇa: 50 palas made one ādhaka and four ādhakas constituted one droṇa. The rainfall was measured by means of a specially prepared round gauge with a diameter of one hasta or cubit (460 mm or 18 inches) and marked off in pala; when filled to capacity it indicated one ādhaka of rainfall (sloka 2). It is believed that the Maurya and Gupta Emperors introduced and popularized this system throughout the length and breadth of their extensive empire and consequently it became an all-India measurement. Many maxims and proverbs current amongst farmers and those close to the soil have their roots in the observations made by Indians millenia ago.

Exploration for underground water and springs

The art of exploring for underground water in India goes back to antiquity, as can be seen from the sixth century BC Jataka stories in which there is a reference to Kusa grass as an indicator of presence of water underground. In chapter 53 of the Brihat Samhitā, Varāhamihira expounds on this subject and calls the art Dakārgala or Udakārgala, which evidently refers to the determination of the presence of water (udaka) below the ground surface with the help of a wooden stick (argala). This art of water divinity is still practised in certain parts of India at the present time. Though reference to this art can be seen in the writings of Sarasvata and Manu, Brihat Samhitā happens to be the only source of information about the state of hydrological knowledge in ancient India. This chapter in Brihat Samhita has been considered unique in the whole range of Sanskrit literature and independent manuscripts of this chapter alone have been discovered.
Varāhamihira says in the first sloka itself
"I shall now explain the science of 'water-finding' which leads to
religious merit and renown, for, it helps men to ascertain the
existence of water; just as there are veins in the human body,
even so do they exist, some higher up, others lower down, in the
earth".

Sloka 2 says that water falls from the sky with the same colour and
taste, assumes various colours and tastes owing to the difference in
the nature of the earth. Hence, it should be examined in relation to
its environments. The presence of water was ascertained mainly
through the presence and type of vegetation, e.g. presence of a
certain tree in a waterless tract, sometimes accompanied by an
ant-hill or a snake's abode. Some of the characteristics of an
aquatic region/vegetation in a waterless area are: a plot overgrown
with grass in a grassless plain or a grassless plot in the midst of a
soil abounding with grass; a thorny tree in the midst of non-thorny
trees; the earth being stamped by feet emits a loud sound; one of
the branches of a tree hangs low or is colourless; the fruits and flowers
of a tree; a kantakara (brinjal?) is seen without thorns but with
white flowers; a date tree with two tops in a waterless place; a
Karnikara or Palasa tree which bears white flowers, and so on.
Varāhamihira also discusses the possibilities of so called water-
veins in desert regions too. An ant-hill to the northeast of a Peelu
tree, indicates water to its west, the underground water running in a
northerly direction at a depth of 25 cubits. The signs would be: in
the first instance a frog, brown clay, then green clay, then below, a
stone and under that the water. In slokas 63-71, Varāhamihira
describes the possibilities of water where ant-hills are present near
tender bamboo, Rohitaka trees, Indra trees and golden trees and the
quality of water varying from sweet to brackist. Various ecological
and environmental interactions are mentioned as indicators of
groundwater under the following headings: (a) phreatophytes,
(b) phreatophytes associated with termite mounds, (c) symbiotic
intergrowth of trees, i.e. a tree united with another tree species,
and morphological, physiological, and mutational features of plants
and plant cover (Prasad, 1984). Slokas 72, 74, 75, 76, 78, 83 and
96 particularly describe the type of trees that show symbiotic
intergrowth and indicate water under the ground. The examples are:
Butea frondosa and Jujube, Marmelos and Glomerous fig tree,
Capparis Desidua and Jujube, Salvadoria and Jujube, and Prosopis
specigera and Butea frondosa. An isolated cold spot in a warm
ground denotes cold water, while a solitary warm spot in cold ground
indicates warm water (sloka 94). A copper-coloured soil mixed with
gravel yields astringent water; pale yellow earth is indicative of
salt, and a blue soil shows the presence of sweet water (sloka 104).
Springs of water in a woody tract (forest) are situated at a lower
level than in open country, and in a desert even lower than in a
woody region (slokas 62, 86, 89 & 93). The appropriate places for
digging wells in villages or towns are indicated in slokas 97 and 98.
Construction of embankments for ponds and the shading of the banks by
trees is advised by him in sloka 119. Similarly, Varāhamihira gives
a recipe for a substance to be added to water. It is a mixture of
anjana, mustā, usra, rājakosātaka, emblic myrobalan and kataka
(slokas 121 and 122). Varāhamihira suggests the asterisms which are
propitious for sinking wells (sloka 123) and ends chapter 54 with comments on exploration for springs.

Varāhamihira could thus indicate the occurrence of water below the surface at depths ranging from 3.43 to 171.40 m with the help of various plants and grass varieties. He quotes earlier works, which are not available now, on hydrology by Baladeva and others, but Brihat Samhita establishes him as the first hydrologist who codified all the then existing knowledge on the subject in his magnum opus.

REFERENCES
