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Review Article

Nature's gift natural mineral water springs: A review

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A R T I C L E I N F O

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A B S T R A C T

Algae play an important role in maintaining aquatic ecosystem and form the base of food chain or food web. Algae classification pertains to rhodophyta, phaeophyta and chlorophyta *i.e.* red, brown and green algae based on their colour pigments. Algae have recently reemerged as promising organisms in the effort to develop sustainable options for production of food and fuel. Algae are divided into two categories: Microalgae and Macrolagae. Himalayan hillock – Himachal Pradesh situated in North West of Himalayas is a rich pocket of diverged algal species due to its favourable climatic conditions. In the present review, an attempt has been made to have a comprehensive documentation of the diversity of algal species that are present in Himachal Pradesh and explore cultivation techniques of these potential species as a rich feed stock mainly for 3rd generation biofuels. Natural hot and mineral water springs have specific role in health and wellness on this earth. As a result of population growth, fresh water will become increasingly scarce and is expected to be the primary constraint for increased food production. Water resource development has taken place all over the world. There is a tremendous amount of pressure in protecting and conserving the natural water resources available in various countries. Protecting the natural freshwater resources in the form of rivers, lakes, streams and springs is important task for human being. This paper reviews the methods that investigate the hydrological systems of springs.

K E Y W O R D S

Natural | Springs | Conservation | Mineral water

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Introduction

Water is critical to life, but it is also a limited resource and several interrelated factors are decreasing its availability (WHO). Springs are the main source of water for millions of people and their livestock. Throughout world peoples living in the hilly areas depend on springs for their livestock and for the drinking, domestic and agricultural needs. The qualities of spring water sources vary widely area wise, depending on location and environmental factors. The factors determining the qualities of natural waters, are chemical composition of the underlying rocks, soil formations and length of time that the water body has been trapped underground (DWAF, 1997). Cold water springs contain a highly diverse invertebrate fauna, including species from both surface and groundwater ecosystems, and also species that appear to be restricted to spring habitats. The biodiversity pattern of springs are strongly influenced by flow permanence, disturbance history, elevation, catchment land use and riparian vegetation structure. Now, springs and their biota face significant threats from unsustainable use of groundwaters and the destruction of spring habitats (Mike *et al*., 2007). In India springs are the major source of freshwater in many small mountainous watersheds within the Himalayan region. In recent years their flow rates have diminished, but the reasons for this rate not self-evident (Pennan *and* Sanmugam, 2016). Moreover, shortage of water freshwater shortage of water throughout the world can be directly attributed to human misuse in the form of pollution. Among surface waters, springs' water is usually considered as safe for drinking and domestic purposes (Aniqa Batool *et al*., 2018).

Natural water springs

Springs are defined as places where groundwater flows naturally from a rock sediment or soil onto the land surface of into a body of surface water. The diversity of springs is indicative of the wide array of geologic and hydrologic conditions which lead to their occurrence. Springs are dynamic and flow in response to changes in climatological, topographical, geological, and geomorphological conditions. Scientifically, most fascinating aspect related to spring flow is the mechanism that create the spring: type of source rock, the character of adjacent of beds, dynamic face, gravity, permeability, geomorphologic process, and geologic structure all-important of spring discharge. Spring water is the common source of the public water supply in most rural communities of developing countries (Van Wijk-Sibesma).

Characteristics of springs

Some important characteristics of springs are:

- Water discharge from spring may be constant or shows variable.
- The springs can be perennial or seasonal
- It is difficult to access springs.
- There is variation in discharge of a spring.
- Variation in spring water temperature to lower or higher.

History of spring water exploitation

Naturally occurring hot springs were particularly valued in colder climates, for example the springs developed by the ancient Romans in Europe. In North America, native

Americans believed in curative effects of hot springs. The thermal baths in Budapest were developed during the Ottaman rule of Hungary, the inspiration was the Islamic tradition of cleanliness. Drinkers of mineral spring waters believed that the water had therapeutic properties and that bathing in or drinking the water could help to treat many common ailments. According to historical documents, Chinese knew about mineral water, especially hot springs. Li Daoyuan who lived in the Beiwei Dynasty (A.D. 386-543), described 41 hot springs from North and South China. The use of spring as a source of water depends in large part on their flow characteristics, both the quantity and constancy of flow. In India, hot springs is a celebrated pilgrimage for the people of Hindu and Sikh belief systems.

Uses of mineral spring water during ancient period

The most popular use of mineral water in ancient time was for medical treatment. However, there were also records of employing hot springs for the cooking and agriculture.

Medical Use: The exploitation of mineral springs with curative properties has long and physical properties which can be exploited for medicinal purposes. In France health tourism is emphatically medicalized with spa therapy or thermalisme (Weiz, 2001). A situation which is partly mirrored in several other European countries (e.g. Germany). Mineral spring water belongs to the oldest medical therapies. Hot springs are therapeutic in nature, as it is Sulphur rich that consist of all healing properties which cure skin diseases and rheumatism among other ailments. So, people quite visit this place. A trend towards natural looking environments or setting is also evident in the marketing of many health resorts and spas, where swimming pools and geothermal bathing facilities are designed and built to look as natural as possible, with rock pools the most typical and widespread design (David, 2010). Studies by Parish and Lotti (1996) support the claim that skin conditions such as dermatitis and psoriasis can be effectively treated by bathing in mineral spring water. Recent research to assess the effectiveness of balneotherapy for rheumatic diseases in Turkey included nearly 4000 patients. This study of Karagulle *and* Karagulle (2009) concluded that most forms of balneotherapy are effective in the treatment of rheumatic diseases. The study presents convincing evidence for the role of natural hot and mineral springs for health purposes from rehabilitation perspective. Pharmacy historical work examines the impact of the use of mineral waters and its health benefits such as –

- Boost Blood Circulation. The water found in natural hot springs contains a variety of different minerals, including calcium and sodium bicarbonate and Sulphur.
- Reduces Stress and Promote Sleep. The mineral water in hot springs can also help to reduce stress by relaxing tense muscles.
- Relieve Pain.
- Heal Skin Problems (Dermal problems).

Agriculture Use. In the book, History of Han Dynasty, written by Sima Biao in the period of Jin Dynasty (A.D. 265-420), it is recorded that there is hot spring 3 km to the south of Cunzhou City, Hunan Province, China. Several hectares of ricefield downstream from the spring, irrigated by warm water. In Chilly

Hokkaaido, Japan farmer uses hot spring to grow mangoes.

Arsenic	-Arsenic in minute amounts may assist the body with plasma and tissue growth. - Foot bathing in mineral waters with a high content of arsenic is used to address fungal conditions of the feet
Bicarbonate	-Balneotherapists utilize bicarbonate waters for bathing to address hypertension and mild atherosclerosis
Boron	-Boron builds muscle mass, increases brain activity and strengthens bones
Chlorides	-Chlorides amount 5-3% are considered by some researchers beneficial for *rheumatic* conditions, arthritis, central nervous system conditions
Magnesium	-Magnesium converts blood sugars into energy and promotes healthy skin
Potassium	-Potassium assists in the normalization of heart rhythms, helps to eliminate body toxins and promotes healthy skin
Sodium	-Sodium and natural salts assist with the alleviation of arthritic symptoms and stimulates the lymphatic system
Sulphur and Sulphates	-Hot springs rich in Sulphur are used to address a wide variety of conditions, including skin infections, respiratory problems, and skin inflammation.

Table. 1: Therapeutic value of mineral content of natural hot and mineral springs (Eyton's Earth, 2010)

Mythology about natural springs

Springs archetypal symbols of life, fertility and vitality. The underground sources of the life-giving waters have naturally attracted a religious significance for those living around them. Cultures from various countries of the world including India, in broad sense do share a belief in a special relationship with nature. The ancient roots of thee mythology and spirituality that is associated with holy springs and the religious conflicts that surround them.

Origin of springs

The complete set of origin, occurrence and concept related to the hydrologic cycle, groundwater and the occurrence of springs is contained in the book of History or Hydrology (Biswas 1970). Biswas research based on discussions on concepts of water on earth by Plato, Tartarus, Aristotle and in early biblical documents. Plato believed that there were numerous interconnected perforations and passages, broad and narrow in the interior of the earth. The water retires with a rush into the inner parts of the earth, it flows through the earth into those regions, and fills them up like water raised by a pump. When it leaves those regions and rushes back hither, it again flows into the nearby hollows, and when these are filled, it flows through subterranean channels and finds its way to several places, forming seas, lakes, rivers and springs.

Religion and springs

Water is considered a purifier in most religions. Its centrality to life is recognized by the many religions of humanity which treat water as holy in their rituals, in the location of their places of worship (Ganesh *et al*., 2006). Some faiths use water especially prepared for religious purposes. Many religious also consider particular sources or bodies of water to be sacred or at least auspicious. Faiths that incorporate ritual washing (ablution) include Christianity, Hinduism, Buddhism, Islam etc. According to Rigveda, all life on this planet is evolved from apah (water). Water is usually acknowledged as the basic need of all living creatures upon the face of this earth. In Vedic literatures, there are copious references about

the medicinal properties of water, uses of water, last but not least the importance of conservation and preservation of water (Sonal Patil, 2015). Clark (1999) provides details of religious use of water in his book 'Japan, A View From The Bath' by giving the example of misogi, an ancient form of purification with water, which features prominently in Shintoism to this day. Arvigo and Epstein (2003) have contributed to knowledge on the religious use of spring water with the book 'Spiritual Bathing: Healing Rituals and Traditions from around the world', in which they argue that water, combined with prayers, has been used for centuries to find a spiritual connection with the Divine.

Classification of springs

Springs form headwater streams as an integrative part of headwater regions and their water network systems. Classifications of spring habitats vary according to their specific features and environmental characteristics. Springs are typified by high water clarity, water temperature and chemical conditions. According to ACWADAM, the springs are classified as:

- Depression springs (formed at topographic lows)
- Contact springs (formed where relatively permeable rocks)
- Fault springs (formed when faulting conditions)
- Joint/Fracture springs (formed where permeable fracture zones in low permeability rocks)
- Karst springs (formed in limestone terrains)

Hydrologic cycle

Groundwater, an active component of the hydrologic cycle, is widely recognized as a critical and vulnerable source (Hertig *and* Gleeson, 2012). Springs are defined as places where groundwater flows naturally from a rock sediment or soil onto the land surface of into a body of surface water. Springs are an important link in the hydrogen cycle. Precipitation is the starting point of the vast unending circulation of the water on the Earth, known as the hydrogen cycle. This system operates chiefly from the energy of the sun. Water is evaporated from the oceans, the land, vegetation, and from smaller bodies of water such as streams, lakes and ponds. The water moves as vapor through the atmosphere where it accumulates as clouds and eventually returns as precipitation both on the land and sea. Springs are a natural part of the hydrologic cycle defined in the Glossary of Geology (AGI 1997). "The constant circulation of water from the sea, through the atmosphere, to the land, and its eventual return to the atmosphere by way of transpiration evaporation from the sea and land surfaces." The hydrologic cycle in which a spring occurs.

Springs Precipitation

Source of all water issuing from springs is precipitation. Spring discharge would vary with temperature and rainfall. Barometric pressure also affects spring flow. The water in springs, seeps, and wells generally originates as rainfall that has soaked into the soil and percolated into underlying rocks. Permeable rocks, such as limestone and sandstone, store and transmit water and are called aquifers. In the hilly regions when snow melts during summer precipitation is high and the water table is also high. The geothermal resources which are generally associated with varying

degrees of therapeutic benefits or curative value due to their mineral content. Naturally occurring minerals are considered to have beneficial effects for the human body, because they can assist in the healing process of a variety of health conditions. These minerals are trace elements which are brought to the surface from groundwater reservoirs where the water is heated at depth by various processes such as pressure, friction, time and/or volcanic activities (Stanwell Smith, 2002) are the most sought-after elements by visitors to health resorts and spas. Apart from individual concentrations of minerals and a broad temperature range, natural hot and mineral springs additional factors like varying pH levels, low level radioactive as well as gases in solution.

Springs Recharge

Natural springs are recharged by precipitation or another surface water source by percolation through the soil and rock. The recharge period occurs during the fall. Recharge is the primary method through which water enters an aquifer. Groundwater recharge, also encompasses water moving away from water table into the saturated zone. Recharge of groundwater may occur naturally from precipitation, surface streams and lakes.

Springs Storage

All rocks have at least some capacity for storing water. In the rocks below the water is stored in fractures, joints, and along bedding-plane partings. Storage is significant with regard to the flow of springs; some poor storability may show wide variability of flow. Generally, storage potential of all rocks decreases with depth.

Springs Discharge

Springs are favoured water sources as they often produce high quality water, are inexpensive to protect and do not require a pump to bring the water to the surface. However, spring water may be rapidly contaminated when it emerges (Bruce *and* James, 2016). The physical forces responsible for bringing groundwater to the surface (Meinzer 1923) who considered that springs result from (1) gravity flow and, (2) artesian flow. Also, some springs flow due to the buoyant effect of gases dissolved in the water. Spring discharge is influenced by spatial variation in topography and geology as well as temporal variation in hydrology and climate. Studies indicated that discharge of springs are affected by variations in rainfall and anthropogenic activities occurring in the recharge area (Rawat 2015). Peak rainfall coincided with peak discharge.

Past civilization

Springs have provided a source of drinking water for peoples and civilization all over the world. Towns would develop near water resources such as rivers, lakes and springs. In ancient times, some rivers like the Nile and Euphrates became the birth places of a civilization. Springs have remained important for all civilization when the flow of rivers ceased during certain times of the year or droughts. The Romans and Italians were attracted by the curative properties of thermal springs and often settled in their vicinity.

Thermal springs

Thermal springs hold a special fascination for many people. If their temperature of spring water is tolerable, “taking the waters” can

provide relaxation, comfort, and alleged health benefits. Many scientists take the natural hot and mineral springs as a serious topic and have analyzed their properties and categorized them according to mineral contents. These terrestrial hydrothermal systems are of major importance in many disciplines. Springs serve as models for understanding the processes in the shallowest part of the geothermal systems that produce epithermal mineral deposits. Commonly the surface manifestation of large subsurface geothermal systems that may be tapped for geothermal energy. Thermal spring deposits are composed mainly of calcium carbonate and silica. Hot and mineral springs are commonly located in a natural environment and have become popular places for relaxation; a leisurely bath in natural hot spring water generally creates a feeling of rejuvenation and invigoration (Levy, 1995).While some of these springs contain water that is a safe temperature for bathing, others are so hot that immersion can result in an injury or death. Heat is created by decay of naturally radioactive elements escaping from the Earth. The rate of thermal spring temperature increases with depth known as the geothermal gradient. Deeply percolated water will be heated when it comes in contact with hot rocks (magma).

Some Best Hot Spring Destinations in the World

The naturally occurring phenomena that are as relaxing and rejuvenation as a hot spring. Geothermal features are a bit like nature's own hot tubs, beautiful locations. United states have more than its fair share of amazing hot springs. But there are plenty of geothermal springs found in other parts of the world too. Here are some 20 of the best one's thermal springs in the world.

According to India waterportal there are five million springs across India, based on current estimates. From the Nilgiris in the Western Ghats to the Eastern Ghats and Himalayas, springs are the sage source of drinking water for rural and urban communities. For many people, springs are the sole source of water. In recent years, their flow rates have diminished, but the reasons for this are not self-evident. It has been found that most Himalayan villages in the state of Uttarakhand and particularly Kumaun region are dependent on spring water.

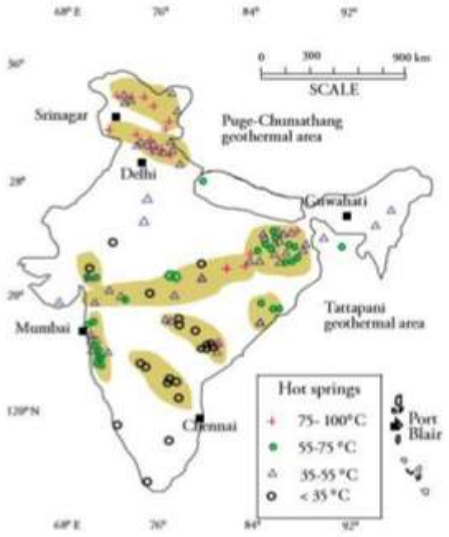

Fig.1: Online of India showing the distribution of major groups of warm and hot springs. Temperatures of the hot spring waters are indicated using symbols.

Nearly 8000 villages were facing acute water shortages due to the drying up of springs in Himalayan region of India (Mahamuni *and* Kulkarni, 2012). Indian states that boast of some of the famous hot springs in India located at attractive tourist places. These natural springs of India contain dissolved chemicals and minerals which are found to be

beneficial to the human body and are believed to possess great medicinal values. Some of the most popular hot springs in India are:

S. No.	Spring	Location
1.	Takaragawa Onsen	Located at Japan
2.	Challis hot springs	Located at Idaho
3.	The Blue Lagoon	Located at Iceland
4.	The Boiling River	Located at Yellowstone National Park, US
5.	The Springs in Pagosa Springs	Located at Colorado
6.	Chena hot springs	Located at Alaska
7.	Olympic hot springs	Located at Washington
8.	Hot Springs National Park	Located at Arkansas
9.	Yangapachen hot springs	Located at Tibet
10.	The Omni Homestead	Located at Virginia
11.	Terme di Saturnia	Located at Italy
12.	Ojo Caliente Mineral Springs	Located at New Mexico
13.	Uunartoq Island	Located at Greenland
14.	Hot Springs Resort and Spa	Located at North Carolina
15.	Chico Hot Springs	Located at Montana
16.	Reykjadalur valley	Located at Iceland
17.	Termas de Puritama	Located at Chile
18.	Deception Island	Located at Southern Ocean

Table 2: Some world-famous geothermal springs throughout the world, Source: **tripsavvy**

S. No.	Spring	Location
1.	Chumathang hot springs	Located at Ladakh, India
2.	Panamik hot springs	Located at Leh, India
3.	Manikaran hot springs	Located at Parvati of Kullu Dist., India
4.	Kheerganga hot springs	Located at Kullu Dist., India
5.	Tattapani hot springs	Located at Shimla, India
6.	Kasol hot springs	Located at Himachal Pradesh, India
7.	Vashisht hot springs	Located at Kullu, Himachal Pradesh, India
8.	Tapovan hot springs	Located at Uttara Khand, India
9.	Gaurikund hot springs	Located at Kedarnath, Uttara Khand, India
10.	Rishikund hot springs	Located at Uttarkashi, Uttara Khand, India
11.	Suryakund hot springs	Located at Yamunotri, Uttara Khand, India
12.	Dhuni Pani hot springs	Located at Madhya Pradesh, India
13.	Reshi hot springs	Located at Sikkim, India
14.	Yumthang hot springs	Located at Gantok, India
15.	Atri hot springs	Located at Odisha, India
16.	Hot springs	Located at Twang *and* Diwang, Arunachal Pradesh, India
16.	Aravali hot springs	Located at Ratnagiri, Maharashtra, India
17.	Akoli hot springs	Located at Vajreshwari, Maharshtra, India
18.	Unakeshwar hot springs	Located at Nanded, Maharashtra, India

Table 3. Some famous hot springs having medicinal importance located in IndiaSource: **traveltriangle.com**

Conclusion

The awareness of geophysical aspects related to natural hot and mineral springs is greater. Hot springs are used as visual attractions within their natural environment. Throughout world many aspects related to the use of spring and groundwater. Springs need to be considered as an integral part of our ecosystem as it helps in the maintenance of spring shed in natural setting and human manipulated situation. The environmental context of springs should be carefully considered when determining management actions to protect, enhance or store ecological integrity.

Threats to spring ecosystems and their conservation

The reduced spring flow include anthropogenic (deforestation) and natural (reduction in rainfall) variation. Springs are among the most threatened ecosystems in the world. Primary anthropogenic impacts include groundwater depletion and pollution, alteration of source area geomorphology, and diversion of runout flow. The increased human intervention, drying of springs is becoming widespread across the Himalayan region in India (Shivanna, 2008). It is important to have a management strategy that often results in the capping of springs and obliteration of the source area. If springs and small seepage canals are managed properly

water scarcity could be averted. Drying up of springs and water scarcity issues underscore the need to increase the understanding of spring hydrology. Protection and rehabilitation of springs may also be required at the local scale, especially on private land, so that representative habitats are maintained within the landscape.

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