INTRODUCTION TO HYDROGEOLOGY

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Fig. 1.1 The achievement of sustainable groundwater development through the balance of recharge inputs to aquifer storage (the groundwater resource) against discharge outputs for economic, environmental and human (social) benefits. After Hiscock et al. (2002).
DEFINITION

Occurrence, distribution, movement and geological interaction of water in the Earth’s crust
Hydrogeology is a truly interdisciplinary discipline involving disciplines such as earth sciences, physics, chemistry, biology, mathematics, statistics, computer science, sociology, economics, law, government policy.
Groundwater development dates from ancient times, as manifest by the wells and horizontal tunnels known as qanats describing a small, artificial channel excavated as part of a water distribution system, which appear to have originated in Persia about 3000 years ago.
In the Peruvian coast the man had planed water resources, struggling against your excess and sometimes against its absence.

Among the most spectacular waterworks are the puquios. A puquio is an underground gallery connecting a point in surface with groundwater. The water flows through it and discharged in a small reservoir (cocha) or directly into irrigation canals. In many cases, is a supply of potable water for human consumption. Spaced along the gallery are holes commonly called eyes.

These connected the surface with the gallery to provide a means of access to the galleries for cleaning. These structures have emerged in response to a long period of drought in the region around the year 560 AD.
3.1a. Diagrama de un puquio de tipo zanja abierta

3.1b. Diagrama de un puquio con galería de zanja rellenada

3.1c. Diagrama de un puquio con galería de tipo socavón
Lago

Nível freático

Furo artesiano repuxante

Nível piezométrico

Furo artesiano

Nascente cársica

Rio

Sumidouro

Área de recarga

Aquífero livre

Aquífero confinado

Nível confinado
Numbers in () represent inventories (in 10^6 km^3) for each reservoir. Fluxes in [ ] are in 10^6 km^3 a⁻¹. After Berner and Berner (1987).
The approximate breakdown of direct groundwater discharge from continents to adjacent oceans and seas is estimated as follows:

- Australia 24 km3 a⁻¹;
- Europe 153 km3 a⁻¹;
- Africa 236 km3 a⁻¹;
- Asia 328 km3 a⁻¹;
- the Americas 729 km3 a⁻¹;
- major islands 914 km3 a⁻¹

  (Zektser & Loáiciga 1993)
• The largest direct groundwater flows to oceans are found in mountainous areas of tropical and humid zones and can reach $10–15 \times 10^{-3}$ m$^3$ s$^{-1}$ km$^{-2}$.
• The smallest direct groundwater discharge values of $0.2–0.5 \times 10^{-3}$ m$^3$ s$^{-1}$ km$^{-2}$ occur in arid and arctic regions that have unfavourable recharge and permeability conditions
  • (Zektser & Loáiciga 1993)
• time taken to replenish the volume (4.2 \times 10^6 \text{ km}^3) of shallow groundwater stored below the Earth’s surface is of the order of 2000 years. In reality, groundwater residence times vary from about 2 weeks to 10,000 years (Nace 1971), and longer (Edmunds 2001).

• A similar estimation for rivers provides a value of about 20 days.
Groundwater is an important natural resource. Worldwide, more than 2 billion people depend on groundwater for their daily supply (Kemper 2004). A large proportion of the world’s agriculture and irrigation is dependent on groundwater, as are a large number of industries. According to a report commissioned for the European Commission (RIVM & RIZA 1991), about 75% of the inhabitants of Europe depend on groundwater for their water supply.
Top Ten Countries by Groundwater Withdrawal, 2000-2010

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Data from Aquastat