



## Short description of Global Groundwater Regions

### NORTH AND CENTRAL AMERICA

#### **Region 1: Western mountain belt of North & Central America**

Region has a complex geological setting, with folded mountains as a dominant feature. Large variation in climate: abundant rainfall in some mountain zones, aridity and permafrost elsewhere. Groundwater is associated with glacial and alluvial aquifers in faulted troughs or basins within mountains, with volcanic aquifers on plateau's and with coastal aquifers. The latter ones, present in structural basins filled with marine and alluvial sediments, are prone to seawater intrusion.

#### **Region 2: Central plains of North & Central America**

Region is characterized by large sedimentary basins and rather flat topography. Sandstones and limestones, deposited in shallow seas, are covered by sediments laid down by streams, wind, and glaciers. Climate is predominantly dry, with permafrost conditions in the north. Regional aquifers are associated with porous or fractured consolidated sediments or with extensive alluvia (e.g. The High Plain aquifer). Glacial sediments in the northern parts may form local aquifers.

#### **Region 3: Canadian shield**

Region has a uniform geological setting, characterized by old igneous and metamorphic rocks at or near land surface. Region receives moderate precipitation (often as snow) and continuous permafrost is present in the northern half. Groundwater is restricted to local pockets of weathered or fractured hard rocks or to shallow layers of alluvial and glacial sediments. Certain areas are susceptible to arsenic contamination.

#### **Region 4: Appalachian highlands**

##### Groundwater characteristics:

Region has a complex geological setting, dominated by folded metamorphic, igneous and sedimentary rocks. Rainfall varies according to elevation. Principal aquifers are found in carbonate rocks and sandstones (e.g. Valley and Ridge aquifers). Local shallow aquifer systems consist of sand and gravel deposits of glacial and alluvial origin.

#### **Region 5: Caribbean islands and coastal plains of North and Central America**

##### Groundwater characteristics:

Region is characterised by thick sedimentary deposits. In the coastal plains, huge seawards-thickening wedges of unconsolidated sedimentary rocks are lying on consolidated limestones and sandstones. On the islands, igneous rocks are overlain by sediments and volcanics. Region receives abundant precipitation. Regional groundwater systems are developed in unconsolidated and (semi-) consolidated sediments. Karst aquifers are frequently found. Sea water intrusion is common.

### SOUTH AMERICA

#### **Region 6: Andean belt**

Region has a complex geological setting, dominated by folded mountains. Large variations in climate occur: abundant rainfall in some of the mountain zones are contrasting with arid zones elsewhere. Groundwater is associated with colluvial aquifers in faulted troughs or intermontane basins, with volcanic rock zones and with coastal aquifers. The latter occur in structural basins filled with marine and alluvial sediments and are prone to seawater intrusion.



**Region 7: Lowlands of South America**

Region is characterised by flat topography and large sedimentary basins. Their consolidated sandstones and limestones are covered with thick blankets of alluvial sediments. Region receives high precipitation in the north and has an arid climate in the south. Unconsolidated alluvial sediments deposited by major rivers form the most important aquifers (e.g. aquifers in the Amazon basin and Puelches Aquifer). Saline water and high concentrations of arsenic and fluoride are common.

**Region 8: Guyana shield**

Region has a uniform geological setting, characterized by old igneous or metamorphic rocks at or near land surface. Region receives high amounts of precipitation. Groundwater is restricted to local pockets of weathered or fractured consolidated rocks or to shallow layers of alluvial sediments. Coastal alluvial aquifers along the northeastern margin are prone to salt water intrusion.

**Region 9: Brazilian shield and associated basins**

Region has two distinctive geological environments: crystalline rock complex and intercalated large sedimentary basins, extensively covered by volcanic rocks (basalts). Region receives high amounts of precipitation. Groundwater in the crystalline rock zones is restricted to local pockets of weathered or fractured zones or to shallow superimposed alluvial layers. In the sedimentary basins, both sandstones (e.g. The Guarani aquifer system) and unconsolidated sediments can form large aquifer systems. The volcanic areas have limited groundwater potential.

**EUROPE**

**Region 10: Baltic shield & Caledonides**

Region has a uniform geologic setting over most of its area, with old crystalline rocks at or near land surface. Minor parts are covered with consolidated sediments and volcanic rocks. Region receives medium to high precipitation. Groundwater in the crystalline areas is restricted to local pockets of weathered and fractured rocks and to shallow layers of overlaying alluvial or glacial sediments. Local aquifers are associated with karstified carbonates (e.g. Waulsortian Aquifer) and recent volcanics (Iceland).

**Region 11: Lowlands of Europe**

Region is flat and characterized by large sedimentary basins containing a thick sequence of consolidated and unconsolidated sediments of marine, eolian and alluvial origin. Region receives medium to high precipitation. The unconsolidated sediments form regional aquifers in the deltas of main rivers. Glacial and eolian aquifers are of local importance. Elsewhere, productive carbonates (e.g. Chalk Aquifer) and sandstone aquifers are found. All coastal aquifers are prone to saline intrusion.

**Region 12: Mountains of Southern Europe**

Region has a complex geological setting, dominated by folded mountain areas and relatively uniform associated sedimentary basins. Large variations in climate occur, with high rainfall in most mountain zones and dryer climates in the lowlands. Alluvial and colluvial fills form local aquifers in the mountain zones. Limestones, sandstones and unconsolidated sediments form large interconnected aquifer systems in some sedimentary basins (e.g. in Po Valley and Hungarian Plains). Coastal aquifers are prone to seawater intrusion.



## AFRICA

### **Region 13: Atlas**

Region has a complex geological setting , dominated by folded mountains. Crystalline and carbonate rocks are locally covered by shallow marine and alluvial deposits. Precipitation shows large spatial and temporal variation; in the southern zone it changes to desert influences. Local aquifers occur in unconsolidated sediments or in karstified limestones

### **Region 14: North African basins**

Region has two distinctive geological environments: large sedimentary basins and crystalline rock outcrops framing these basins. Climate is arid. Sandstones and limestones form regional aquifers, some of which are deep and receive no modern recharge (e.g. Nubian Sandstone Aquifer), while others are recharged in river valleys (e.g. Iullemeden Aquifer System). Groundwater in the crystalline rock zones is restricted to local pockets of weathered or fractured rocks or to shallow layers of alluvial sediments. Groundwater in the northern part of the region is often saline.

### **Region 15: West African basement**

Region is dominated by crystalline rocks, with local sedimentary basins filled with sandstones , limestones or unconsolidated sediments. Climate is humid in the north and becomes dry towards the south. Groundwater usually is restricted to local pockets of weathered or fractured rocks or to shallow layers of alluvial sediments, but deltas of large rivers (Volta and Niger) have more favorable groundwater conditions. High fluoride concentrations occur locally.

### **Region 16: Sub-Saharan basins**

Region is dominated by sedimentary basins and isolated outcrops of crystalline rocks. Climate is humid in the north and dry in the south. Large regional aquifers are found in unconsolidated sediments (e.g. in Congo basin ) and fractured sandstones (e.g. Karroo Aquifer system). Limestone and dolomite layers (e.g. Katanga System) form local aquifers.

### **Region 17: East African basement**

#### Groundwater characteristics:

Region is dominated by crystalline rocks at or near land surface. Climate is humid in the north and dry in the south.. Groundwater is restricted to local pockets of weathered or fractured zones or to shallow layers of alluvial sediments. High fluoride concentrations occur locally.

### **Region 18: East Africa rift and associated basins**

#### Groundwater characteristics:

Region has a very complex geological setting, with rock types varying from old crystalline rocks to recent volcanics. Climate is predominantly arid to semiarid, with some humid zones. Carbonates, sandstones (e.g. Karroo Sandstone) and coarse unconsolidated deposits form regional aquifers. Volcanic areas have local aquifer beds in sediments interbedded between successive lava flows. Groundwater in crystalline rocks is restricted to locally fractured and weathered zones. High fluoride concentrations are common. Coastal aquifers are prone to salt water intrusion.



## ASIA

### **Region 19: West Siberian platform**

Region is dominated by large sedimentary basins covered by alluvial and lacustrine sediments. Climate is cold and dry. The northern part of the region within the permafrost zone. Main aquifers are associated with coarse layers in alluvial sediments. Fractured sandstones form local aquifers.

### **Region 20: Central Siberian plateau**

Region has two distinct geological environments: large sedimentary basins and outcrops of old crystalline rocks (predominantly dolerite). Climate is cold and dry. The northern half of the region is within the permafrost zone. Alluvia associated with large rivers (e.g. Lena) and fissured limestones and sandstones form potential aquifers. Crystalline rocks have a low groundwater potential, restricted to the weathered zones.

### **Region 21: East Siberian highlands**

Region has a complex geological setting with old crystalline rocks, large sedimentary basins and folded mountain belts. Climate is cold and dry. Almost the entire region belongs to the permafrost zone. Groundwater occurrence is restricted to fractured or weathered zones in crystalline rocks and consolidated sediments. Local aquifers are associated with unconsolidated alluvial sediments.

### **Region 22: Northwestern Pacific margin**

Region has a complex geological setting, characterized by uplifted sedimentary rocks and recent volcanic activity. Climate varies from cold and dry to hot and moist. Groundwater occurs in fractured and fissured sandstones and limestones, but porous volcanic rocks and locally thick unconsolidated sediments form also important systems (e.g. Tokyo Group Aquifer System). Thermal zones, associated with volcanic activity, may affect groundwater quality.

### **Region 23: Mountain belt of Central and Eastern Asia**

Region has a complex geological setting, with crystalline rocks dominating in the northern half, while crystalline and volcanic rocks alternate with consolidated and unconsolidated sediments in the southern half. The highlands have low precipitation and high evaporation, while coastal areas have a humid climate. Local aquifers occur in fractured volcanic rocks, karstified carbonates or unconsolidated sediments. Uranium deposits locally affect groundwater quality.

### **Region 24: Basins of West and Central Asia**

Region is dominated by large sedimentary basins. Thick layers of consolidated and unconsolidated sediments include loess. Climate is arid to semi-arid. Regional aquifers occur in fractured sandstones, karstified limestones (e.g. Erdos Basin Aquifer) or alluvial sediments. Groundwater in the loess deposits is associated with the presence of permeable paleo-soils and is considered to be an important local resource.

### **Region 25: Mountain belt of West Asia**

Region has rugged topography a complex geological setting, with folded mountains as a dominant feature, in association with relatively uniformly filled sedimentary basins. Climate is predominantly dry, with some humid zones at higher altitudes. Alluvial and colluvial fills form local aquifers in relatively flat zones of the mountain complex. Limestones, sandstones and unconsolidated sediments in the sedimentary basins form interconnected aquifer systems. Coastal aquifers are prone to seawater intrusion.



**Region 26: Himalayas and associated highlands**

Region has very irregular topography and a very complex geological setting, dominated by intensively folded crystalline, volcanic and sedimentary rocks. Climate varies from warm to cold and from humid to arid. Large areas are covered by glaciers or seasonal snow. Alluvial and colluvial fills in relative flat zones may form extensive aquifers (e.g. Kathmandu Valley). Local aquifers occur in karstic limestones and fractured sandstones.

**Region 27: Plains of Eastern China**

Region is rather flat and dominated by large sedimentary basins. Thick covers of unconsolidated sediments are associated with major rivers draining enormous catchment areas. Region receives low to medium precipitation. Extensive alluvial aquifers (e.g. Huang-Hai-Hai Plain Aquifer) store large volumes of groundwater. Zones with saline water are common.

**Region 28: Indo-Gangetic-Brahmaputra Plain**

Region is dominated by large and deep alluvial basins. Very thick layers of unconsolidated sediments are associated with major rivers draining the Himalayas. Climate varies from arid to humid, as the mean annual rainfall increases from west to east. The extensive alluvial aquifers are interconnected and constitute together one of the largest groundwater reservoirs in the world. Zones with saline water and high arsenic concentration are common.

**Region 29: Arabian shield**

Region is dominated by old crystalline rocks at or near land surface, partly covered by sediments and volcanic rocks. Climate is semi-arid to arid. The crystalline rock areas have a limited groundwater potential, but relatively large regional aquifer systems are associated with unconsolidated sediments in coastal plains (e.g. Tihama) and deltas. Fractured sandstones, limestones and volcanic rocks form important aquifers of limited lateral extent. Coastal zones are prone to salt water intrusion.

**Region 30: Levant and Arabian platform**

Groundwater characteristics:

Region is dominated by large sedimentary basins. Climate is predominantly arid, but varies from humid along the northern edges to hyper arid in the interior zones. Large regional aquifer systems are found in sandstones (Mukalla Aquifer System) and in fractured carbonates (Umm-Er-Radhuma Aquifer). Some of these aquifers are deep and have negligible modern recharge. Unconsolidated alluvial sediment form aquifers of local importance along main wadis. Zones with saline water are frequent, both inland and along the coast.

**Region 31: Peninsular India and Sri Lanka**

Region is dominated by old crystalline rocks, partly covered by volcanic rocks and sediments. Climate varies from arid to humid. Groundwater is mainly restricted to local pockets of fractured and weathered rocks, local sedimentary basins or shallow alluvial sediments. Sedimentary intercalation between lava flows (intertrappeans) and coastal alluvia may have a higher groundwater potential. High fluorine concentrations are common. Coastal zones are prone to seawater intrusion.



**Region 32: Peninsulas and Islands of South-East Asia**

Region has a complex geological setting, including crystalline rocks, consolidated and unconsolidated sediments and volcanics. Climate is predominantly humid. Groundwater in the crystalline and volcanic rocks is restricted to local pockets of fractured and weathered zones. Unconsolidated sediments and fissured sedimentary rocks (karstic zones in Vietnam) form regional aquifers. Groundwater in volcanic areas may have high fluoride concentrations. The coastal zones are prone to seawater intrusion and/or land subsidence.

**AUSTRALIA AND OCEANIA**

**Region 33: West Australia**

Region has two distinctive geological environments: large sedimentary basins and crystalline rock complex. Climate is semi-arid to arid. Groundwater in the crystalline and volcanic zones is restricted to local pockets of fractured and weathered rocks or shallow layers of alluvial sediments. Fissured sandstones (e.g. in Canning Basin) and limestones (e.g. in Eucla Basin) form large regional aquifers. The rate of renewal of groundwater is small in comparison to the total groundwater storage. In many parts, groundwater is saline.

**Region 34: East Australia**

Region is characterized by large sedimentary basins and small uplifted areas. Climate is semi-arid to arid. Thick layers of sandstones form one of the world's largest aquifer systems (Great Artesian Basin Aquifer System). Fissured limestones aquifers occur as well (e.g. Murray Group Aquifer), while alluvial fans, associated with larger rivers, form important shallow aquifers. The uplifted areas themselves have only local aquifers, found in fractured rocks. Recharge is generally limited and high salinity of groundwater is common.

**Region 35: Islands of the Pacific**

Region has different geological environments, characterized by uplifted crystalline rocks, sedimentary basins and recent volcanics. Climate is humid. Some of the recent volcanic rocks are very porous and contain large volumes of water. Karstified limestones and porous calcareous formations in coastal areas are also important aquifers. Local aquifer occur in unconsolidated alluvial sediments. Fresh water lenses in the aquifers are usually shallow and saline water intrusion is common.