

### 1.3 Hydrologic Pathways

The wet season cultivation of rice in bunded paddy fields has similar effects on basin hydrology as does the capture of run-off in hydropower reservoirs. Rainfall is trapped in bunded fields and re-evaporated or transpired to the atmosphere. During wet season dry spells, streamflow is redirected to paddy fields and also evaporated or transpired to the atmosphere. Dry season irrigation however has the opposite effect on basin hydrology to reservoir storage hydropower scheme operations, which augment downriver dry season stream flows. The dry season irrigation of rice in ponded paddy fields abstracts up to three times as much water from the river system as does the ditch and bed irrigation of alternative crops.

In poorly designed, poorly constructed or poorly managed, irrigation schemes, water consumption per unit area or per unit of product can be more than double that pertaining to schemes of a higher standard. In addition to impacts on hydrology, irrigation may also have ramifications for water quality, aquatic biodiversity, soil structure and soil fertility - the latter especially where saline horizons underlie fields not equipped with efficient surface drainage systems.

Expansion of wet season irrigation will augment the impacts of the NT2-HPP in ameliorating downstream flood levels in the Xe Bangfai Basin, along the Mekong mainstream floodplains, in the Great Lake Basin and in the Mekong Delta. This amelioration, if indeed significant, would be potentially advantageous to all tracts except for the Great Lake, where it would have a negative effect on the fishery due to reduction of the effective area of the lakeshore fish spawning grounds. Dry season irrigation, on the other hand, would have the opposite effect on river levels to that of operation of the NT2-HPP.

Irrigated agriculture is responsible for 80-90% of the water abstractions from the Mekong Basin waterways. Urban water supply and industrial use accounts for the remainder. Irrigation water is sourced from stored rainfall and runoff, stored floodwaters, pumping and diversions from rivers and streams including the Mekong, and to a smaller extent by pumping of ground water resources.

#### The Hydrologic Cycle

Water vapour in the atmosphere condensing into clouds is deposited on the land surface in the form of rain, snow, hail, dew, mist or frost. Through the hydrologic cycle, it is returned to the atmosphere via one or other of the following routes:

- Direct evaporation from the wetted leaf surfaces of terrestrial plants
- Precipitated atmospheric moisture enters the various water bodies through one or the other of the following routes:
  - *Direct surface runoff.* Runoff from undisturbed old-growth forest will have virtually zero suspended sediment. If a forest has been disturbed by exploitive logging however, or by clear felling, runoff may contain a certain amount of suspended sediment. Direct surface runoff from grassland is approximately double that to be expected from undisturbed, old-growth forest. If the grassland is burnt or over-grazed, runoff will contain suspended sediment. Direct runoff from sloping agricultural land will be very high in suspended sediment if soil erosion control measures are not installed. Runoff water cleanliness will also be compromised if excessive amounts of chemical fertilisers or pesticides are applied to the agricultural land. Suspended sediment and chemical pollution have a depressing effect on fish populations.
  - *Shallow aquifer.* Part of the precipitation, which is infiltrated into the soil and is not transpired into the atmosphere, may percolate laterally into the water bodies. The time taken for precipitation to reappear as stream flow varies with many factors such as: distance, slope and shallow aquifer transmissivity. Notwithstanding, percolation of heavy rainfalls into the soil horizon does have a significant flood peak amelioration effect.
  - *Deep Aquifer.* The portion of precipitation that penetrates deeper than the shallow aquifer on sloping terrain, may take several years to reappear as stream flow. Percolation into the deep aquifer is greatly facilitated by the presence of tall trees, whose roots penetrate and open up cracks in the bedrock and, when they die, provide the channels for deep infiltration.
- Direct evaporation from the surface of terrestrial water bodies, stream, rivers, lakes, ponds, wetlands, reservoirs or paddy fields.
- Transpiration by growing plants (note: this only occurs while soil moisture in the plant's root zone is above wilting point). Some deep-rooted trees may transpire moisture from the soil throughout the dry season whilst shallow-rooted grasses will cease transpiration by the end of the cool-dry season.
- The hydrologic cycle is completed by direct evaporation from the ocean, forming clouds that eventually deposit rain onto the land surface.

### 1.3.1 *Water Loss Mechanisms*

Prior to agricultural and infrastructural innovation by humankind, the entire land surface of the Mekong Basin was forested, ranging from mangrove forests in the Delta through swamp forests in the flood retention wetland, moist and dry evergreen forests on the better lowland and upland soils, dry dipterocarp forests on the thin shallow soils and coniferous forests on the higher slopes. Reservoir-impoundment hydropower schemes, such as the existing Ubon Rattana and Pak Moon Schemes in Thailand, the Nam Ngum I Scheme and the proposed Nam Theun 1, 2, and 3 Schemes in Lao PDR, impound wet season run-off and store it for hydropower generation in the dry season. Impoundment reduces average downstream river levels in the wet season, whilst the water released by power generation, increases the average dry season river levels.

In irrigation system terminology, 'water loss' refers to that amount of water diverted or pumped from the water source that leaks or evaporates en route to the roots of the crop and therefore does not contribute to transpiration through consequent growth. Such losses include:

- Seepage through the bottom or sides of canals,

- Overflows into emergency spillways or across tail regulators, due to poor operational procedures
- Discharges into drains.

Such losses are particularly serious economically when diesel fuel or electric power is expended in pumping water into the distribution headworks. It is only the evaporation and transpiration losses that represent a loss to the Basin's hydrological network however, as linkages, spills and drainage eventually return into the mainstream flow.