**Additional material**

**4.1 Ecological character**

Deltaic freshwater and desalinated wetlands

These wetlands cover 102,800 ha (59.8% of the total area) and comprise a complex of open water bodies (limans), reed-beds and terrestrial habitats. The limans are fed mainly by the Kuban's fresh water. The water supply of the Kulikovsko-Kurchanskaya group of limans consists of waters coming from the rice fields to the extent of 70%, the rest is the Kuban's water. The Zhesterskaya and Chernoyernikovsko- Sladkovskaya groups of limans are fed by the river water, the Akhtaro-Grivenskaya group and the Bolshoi and Maly Kirpilsky limans receive water from the irrigation systems, and the rest of these wetlands are supplied by river waters.

The following habitat types are distinguished within this group:

* Terrestrial habitats: ridges, levees and other higher sites cover 21,600 ha (12.6%). Steppe meadows occupying the highest places are dominated by *Koeleria cristata, Festuca valesiaca, Madicado minima, M.orbicularis, Oposma tinctorium, Stipa pennata, Agropyreta pectinati* and *Festuca beckeri*. At lower sites, meadow species are found, including *Calamagrostis epigeios, Poa trivialis, Potentilla reptans* and *Trifolium pratense*. Marshy meadows are represented by the sedge and grass-sedge meadows with *Glyceria arundinacea* and common reed *Phragmites communis*. Some of these habitats are hardly accessible and provide refuges for wildlife and breeding grounds for a wide range of waterbirds.
* Reedbeds located between/by the limans cover 43,100 ha (25%) and include:

1. Temporarily flooded reedbeds (14,000 ha; 8.1%): These wetlands dry out in summer due to the seasonal decrease in river flow and diversion of water to irrigation canals. Sometimes water flows 2-3 km off the gently sloping shore following strong winds. Pure reeds comprise 53% of the habitat area. The degree of basal coverage is 80-90% and the weight of dry matter is 297 metric centners per ha. The reed stems are quite large at these sites: 370-520 cm in height and 1.1-1.3 cm in thickness, with 15 to 66 stems per 1 m2. These reeds provide refuges for wild boar *Sus scrofa* and nesting sites for herons.
2. Permanently flooded reedbeds (29,100 ha; 16.9%): Dense reedbeds occur at the edges of limans in shallow waters down to 1.5 m deep. Pure reeds occupy 67.1% of the area covered by this habitat. The total number of phytiums is up to 10. Beds of narrow-leaved cat's-tail Typha angustifolia cover to 20% of the area occupied by emergent plants, with the basal coverage of 60 to 70% and productivity of 256 centner/ha. Broad-leaved cat's-tail Typha latifolia comprises 0.1% of the area with productivity of 148 centner/ha. At the edge of open waters, the common reed develops associations with submerged and flowing plants, such as Potamogeton nodosus, Huphar lutea, Ceratophyllum demersum, Lemna trisulca, L.minor, Salvinia natans, Hydrocharis morsus- ranae and Aldrovanda vesiculosa. In the late 1980s and early 1990s, permanently inundated reedbeds largely increased in area due to an increase in concentrations of nitrogen, and the area of open water reduced. Habitats of this type provide feeding, roosting and nesting sites for coot Fulica atra and other Rallidae, dabbling ducks and herons.

* Open waters of limans and lakes have a total area of 38,100 ha (22.2%) in this group of habitats. *Nymphaea alba* (weight of dry matter: 38 centners per ha) and *Trapa natans* (80 centner/ha) are widespread. Shallow areas of limans are overgrown with submerged plants: *Potamogeton perfoliatus* (17.7% of the area, degree of basal coverage 5-10%, productivity 50.1 centner/ha), *Potamogeton pectinatus* (4.8% of the area, degree of basal coverage 70-80%, productivity 95 centner/ha), *Myriophyllum spicatum* (2.8% of the area, productivity 51 centner/ha) and *Ceratophyllum demersum* (1.8% of the area, degree of basal coverage 70-85%, productivity 76 centner/ha). At other sites of the open freshwater area, associations of submerged and floating plant species are found in the following compositions: *Stratiotes aloides* with *Nymphaea; Ceratophyllum* with *Chara; Potamogeton perfoliatus* and *Potamogeton crispus*. *Stratiotes aloides* forms homogeneous coverage sometimes over the whole water body. *Vallisneria spiralis* also forms pure subaqueous meadows with the degree of coverage of 60-80%. *Nelumbo nuciferum* is less abundant. *Nymphoides peltatum* occurs sporadically.

Intermediate or barrier type of wetlands: brackish water bodies

These cover 48,600 ha (28.1%). The wetlands are fed mainly by fresh waters (70%), but also receive water from the sea and other saline sources. The following habitat types are recognized:

* Terrestrial habitats (ridges, levees and other higher sites) cover 8,200 ha (4.8%). Associations of steppe species include *Artemisia + Agropyron pectiniforme, Festuca sulcata + Stipa*, etc. At saline meadows, formations of herbs, sedges, *Stipa* and gramineous species occur, including *Alopecurus arundinacues, Tripolium pannonica, Carex extensa* and *Scirpus tabernemontani*.

Marshy sites are dominated by sedges and grasses: *Carex riparia, C.vulpina, C.acuta, Agrostis stolonifera* and *Glyceria maxima*. For the most part, these habitats are almost inaccessible for people due to the dense reedbeds around them.

* Reedbeds located between/by the limans occupy 18,900 ha (10.9% of the total area). Within this type, three variants can be distinguished:

1. Temporarily flooded reedbeds cover 6,600 ha (3.8%). These wetlands are periodically flooded and dry out again depending on the winds, irrigation practices and general climatic and inundation conditions of the year. In hypersaline wetlands, there is no vegetation and only spots of salt are found on the ground when these wetlands dry out. Common reed is a dominant species but reedbeds are not so dense and less productive in comparison with those in freshwater habitats. Other common species include *Schoenoplectus litoralis* and *Bulboschoenus maritimus*. The latter occupies up to 1.7% of the area with productivity of 83.7 centner per ha. These wetlands provide foraging areas and refuges for wildlife.
2. Permanently flooded reedbeds have an area of 12,300 ha (7.1%). Seven reed formations are found there. The average number of reed stems per 1 km2 is 99 (80-136); height of stems is 252 (150-

340) cm; and productivity is 180-250 centner/ha. Reed grows in the waters to 60-80 cm deep, covering to 69.8% of the habitat area. Cat-tail occurs only at shallows (mainly *Typha laxmanni*). *Bulboschoenus maritimus* is less abundant and occurs at depths down to 105 cm (2.2% of the area, 84 centner/ha). At the edge of the open water area, reeds become sparse and other euryhaline and halophytous species appear: *Potamogeton pectinatus, Myriophyllum spicatum, Chara intermedia, Ruppia spiralis* and others. This habitat is important for coots, ducks, grebes and some other birds.

* Open waters have a total area of 21,500 ha (12.5%). *Potamogeton pectinatus* and *Myriophyllum spicatum* develop pure formations as well as associations with other submerged and floating plants. The degree of basal coverage comprises 69 to 85%. Areas of open water are important for a great number of waterfowl, including swans, gulls and grebes.

Foredelta water bodies

These wetlands are directly connected with the sea and supplied mostly by the sea waters. They occupy 12,800 ha (7.5%). Four habitat types are recognized:

Terrestrial habitats have a total area of 2,400 ha (1.4%) and are represented mainly by solonetz, solonchaks and other areas with salty soils. At higher sites, steppe vegetation occurs. *Festuca sulcata* is widespread in associations with *Artemisia* and various herbs. *Aeluropus litorallis* is a common species for saline meadows. *Atriplex verrucifera, Limonium caspium, Halocnemum strobilaceum* and *Artemisia* are found at solonchaks. Wet solonchaks are overgrown with *Salicornia herbacea*. Sparse reeds sometimes occur.

* + Reedbeds located between/by the limans cover 5,100 ha (3.0%), including:
  1. Temporarily flooded reedbeds (2,000 ha, 1.2%). Reed is mainly thin-stemmed in these wetlands. At the edge of the water area, *Schoenoplectus compactus, S. triguete* and *Bulboschoenus maritimus* are found. Hypersaline sites lack vegetation. These reedbeds provide good nesting and hiding conditions for many birds.
  2. Permanently flooded reedbeds (3,100 ha, 1.8%) are represented by pure reed formations developing in saline waters down to 10-15 cm deep. Reed is thin-stemmed, with 107-157 stems per 1 km2, 140-300 cm high. Productivity is 120-200 centner/ha. *Bulboschoenus maritimus* occurs at a depth to 65 cm, occupying 1.8% of the total area. At the edge of reedbeds, *Zannichellia major* occurs. Islands and other less accessible parts of this habitat are used by cormorants, gulls and other birds for breeding.
  + Open water areas of lakes and limans total 5,500 ha. The vegetation is poor due to high salinity of waters. Halophytes (*Ruppia maritima, R.spiralis, Aeluropus litoralis, Najas marina* and *N.minor*) are common for the foredelta areas bordering on the sea. These wetlands provide important feeding and roosting grounds.

Marine habitats

Open sea bays and extensive coastal shallows with adjacent sand and coquina beaches occupy 7,800 ha (4.5%). The following habitat types are distinguished within this group:

* + Terrestrial habitats cover 4,300 ha (2.5%). The coastal part of the Kuban Delta is distinguished by its clearly defined zoning structure: a strip of sand and shell limestone gives way to moving sands with psammophytes, which in turn changes for a zone with halophilic and meadow species.

Sparse forest plantings and groups of trees or bushes (15 species) are found along the coast. At fixed sands, *Carex praecox, Iuncus maritimus, Elytrigia maeotica* and *Melilotus albus* occur. Such species as *Artemisia campestris, Astraglus excarpus, Plantago indica, Erungium maritimum* and *Hordeum geniculatum* appear closer to the sea. For moving sands, *Elymus arenarius* and *Calcile maritima* are common. Scarce reedbeds occur at some places. Lower sites flooded with sea waters and muds are also found at the beach.

* + A 400 ha breakers zone (0.2% of the area) is bare. Sand and coquina bars are common.
  + Coastal shallows to 4-5 m deep cover 4,300 ha (2.5%). The floor is formed with sand and shell limestone. Flat bare islands develop along the shore. Plants include *Ruppia* and *Zostera* species. Waterbirds are represented mainly by gulls and cormorants; in winter, also by wildfowl and grebes.

Wetlands of different types, especially brackish ones, may turn into each other quite rapidly, depending on the amount of water supply and anthropogenic impact

**4.5.1 Ecosystem services**

Agriculture: Irrigation is necessary to ensure the success of farming activities in the region. The diversion of water causes frequent changes in water level in reservoirs and also reduces the flow through the delta. Under natural conditions, the wetlands in the delta received 5.3 km3 of water annually, presently this has decreased to 1.4 km3. The runoff from 123,000 ha of irrigated fields, entering limans, comprises 1.2-1.6 km3 annually (Chebanov,1989). Pesticides are applied in large quantities: up to 42 tons annually (for 8.2 x 106 ha of arable land in the whole of Kuban catchment area). The amount of pesticides reaching the Kuban Delta was estimated at 25.8 t in 1986-1989. A decrease in inputs of phosphorus and an increase in nitrogen have been recorded. Excessive concentrations of nutrients cause rapid plant growth in the wetlands. Discharges of sulphate ions entail the development of zones with dissolved hydrogen sulphide in limans and the Sea of Azov. Toxic substances are also detected in the water. Concentrations of DDT and hexachloride (HCCH and derivatives) vary from 0.01 to 0.08 mg l-1.

Mowing and grazing are traditional activities which are carried out on the islands, peninsulas, spits, floodplain meadows and ‘plavni’ areas. The present economic situation has closed large cattle- breeding collective farms, which is expected to give rise to private farming and reduce the damage resulted from the high concentration of the stock.

Fishery: Commercial fishing is conducted with nets and seines in the sea and limans, and is permitted within the Ramsar site and nature reserves. Sport fishing is allowed only with rod and line. In recent 40 years, the catches of all commercially valuable fish species have decreased dramatically (zahrte *Vimba vimba* by a factor of 50, zander by a factor of 4 and pomfret by a factor of 5). To compensate for this, hatcheries have been developed and millions of juvenile sturgeon, zahrte and *Chalcalburnus chalcoides* are released into the Kuban every year. There are more than 20 fish farms in the area, and many ponds, limans, reservoirs and the delta channels are used for fish growing, including such species as zander, pomfret, sazan *Cyprinus* sp., etc.

Forestry: These activities have positive effect on the whole ecosystem, with species and habitat diversity increasing as a result of forest planting. The total area of forest is 4,600 ha. However, in the mountains outside the site, logging continues, and leads to increased run-off and alteration of hydrological regime.

Waterfowl shooting: Shooting is allowed during the period 20 September to 20 December. Limits are set on the number of visits (not more than 3 days a week) and the daily harvest (two geese and ten ducks and coots). In some years, shooting for drakes (using decoys) is allowed in spring during one week. The shooting is considered to have little effect on the waterfowl populations.

Recreation: There are a number of resorts in the coastal area, including Eisk, Tempyuk and Primorsko- Akhtarsk. Popular recreation activities include sport shooting for waterfowl and fishing. 200,000 people take part in this kind of recreation. The recreational pressure is relatively low.