

RAWES-based analysis of perceived ecosystem service benefits, geographical scales, potential markets and some explanatory comments.

		Perceived service benefit	Scale of benefits	Potential PES arrangements (who and how?)	Are there any comments or observations you'd like to make about your assessment of consequences?
Provisioning services	Fresh water available for abstraction and use	Significantly positive	Local and city	Water service beneficiaries (government, local water providers, direct users)	Draw upon hydrological data of water flows from the park, and quantification of abstracted and directly exploited water (including monitored output from/through Tulsi Lake)
	Food production (e.g. crops, fruit, fish, etc.)	Positive	Local	Quantify by replacement cost for food used	Land crabs are harvested by local people (and there is small-scale illegal subsistence fishing in Tulsi Lake)
	Fibre and fuel production (e.g. timber, wool, etc.)	Positive	Local	Local users (possibly monetised by replacement cost with bottle gas)	Local people take a limited amount of fallen wood for fuelwood and other domestic needs (though technically illegal)
	Genetic resources (used for crop/stock breeding and biotechnology)	Not exploited	-		This is a potential service but exploitation is against the principles of setting up the park
	Biochemicals, natural medicines, pharmaceuticals	Not exploited	-		This is a potential service but exploitation is against the principles of setting up the park
	Ornamental resources (e.g. shells, flowers, etc.)	Positive	Local and city	Estimate the value of resources collected versus the cost of mementos bought in tourist shops	Limited informal collection by park visitors of leaves, feathers and other ornamental resources
	Harvesting of clay, minerals, aggregates, etc.	Not exploited	-		This is a potential service but exploitation is against the principles of setting up the park
	Waste disposal	Not exploited	-		Not allowed
	Energy harvesting from natural air and water flows (if relevant)	Not exploited	-		Not allowed
Regulating services	Air quality regulation	Significantly positive	Local and city	Comparison of air quality in central versus park periphery with (if possible) health costs	Mumbai air quality is a major problem, substantially ameliorated locally by SGNP
	Local climate regulation – microclimate, temperature, precipitation	Significantly positive	Local and city	Use met office data from inside and outside the park to get a metric of microclimate amelioration effect. Quantify, if possible, heat stress effects on human health	Mumbai's microclimate, heat island effect, etc. is a major challenge, but the park habitat has a major ameliorating effect

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Regulating services	Global climate regulation – greenhouse gas sequestration, etc.	Significantly positive	Global	Use literature on carbon sequestration rates in different dominant habitat types to produce a metric, and use international carbon market values to monetise. (Potential PES market could be drawn directly from REDD+.)	The varied habitats across the park have high biomass and soil carbon sequestration potential
	Water regulation (timing and scale of run-off, flooding, etc.)	Significantly positive	Local and city	Quantify the area of Mumbai real estate at flood risk were the service of the park not to be there, multiply by economic detriment of buildings at flood risk to derive a total. (PES potential from insurance providers.)	Complex forest habitat buffers water flows regulating extremes of drought and flood. The buffer effect of Tulsi, Vihar and Powai lakes also result in rivers flowing for relatively longer times in the dry season. The Mithi Flow disaster is an example of flooding and spreading of urban pollution, raising questions about how much worse the flood would have been were the park's buffering effect not present
	Natural hazard regulation (i.e. storm protection)	Significantly positive	Local and city	Quantification of damage averted to buildings and infrastructure can potentially be monetised. (PES potential exists, but difficult to identify buyers.)	Storm buffering by trees and also the geological structure of the park dissipates wind energy, averting damage to surrounding buildings and infrastructure
	Pest regulation	Significantly positive	Local and city	Costs of artificial pest control could be quantified. (Potential PES could be based on cost savings to urban park management services.)	The park hosts many pest predators (birds, insects, bats, etc.). There are few croplands close to the park, which limits realisation of the service, though benefits also accrue to gardens, street trees, parkland, etc.
	Disease regulation – human	Unknown	?		Aside from health benefits of green exercise, air and water quality, additional health benefits need to be investigated
	Disease regulation – livestock	Unknown	?		Few livestock surround the park, so the benefit may be small positive or negative but more study is needed
	Erosion regulation	Significantly positive	Local	Can we estimate the cost saving from desilting dams and nullah downstream?	Extensive green cover stabilises park soils, also stabilising river courses and averting the costs of desilting downstream
	Water purification and waste treatment	Significantly positive	Local and city	Could be related to substitution costs of additional water treatment were the service not occurring. (PES market possible with urban water service providers.)	Diverse SGNP habitat slows the flows and purifies water, Tulsi and Vihar Lakes also serving not only as an intermediate storage facility but also further purifying water in transit from remote catchments into the city

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Regulating services	Pollination	Positive	Local and city	This may be a tough one to monetise in a Mumbai context!	Substantial numbers of pollinating species (insects, sunbirds and other birds, bats, etc.) occur in the park maintaining its diversity, with benefit spreading to food, gardening and urban parkland beyond the SGNP boundary
	Salinity regulation – implications for soil salinity build-up	Positive	City	It may be possible to quantify through a plant regeneration survey in the SGNP, including whether insect, bird or other pollinated	Regulation of salinity in estuaries outside the SGNP and influences by outflowing streams, maintaining the salinity regimes upon which mangrove survival (and associated biodiversity and services) depends
	Fire regulation – tendency of ecosystems in the catchment to burn	Not relevant	-		Fire regulation happens in the forest through moisture in leaf litter, benefitting the ecosystem in many ways, but there is not necessarily a benefit to people
	Noise and visual buffering – impacts on the buffering effects of ecosystems	Significantly positive	Local and city	Quantification could be based on the stress of urban as opposed to 'green' views (for which there is health-related literature)	Massive noise and visual buffering effects result from the presence of geological structure and biodiversity (particularly trees) in SGNP, quietening the noise of the city and blocking intrusive lights and other visual blight
Cultural services	Cultural heritage	Significantly positive	Local, city and national		The presence of SGNP is a defining feature of Mumbai city, the surrounding area and of Maharashtra, and also as part of Indian national identity
	Recreation and tourism	Significantly positive	Local, city, national and international	Quantify visitor numbers and investment in travel, accommodation, food, gate fees, related small businesses, etc. (Effectively, gate fees are a type of PES, or payment for a service)	Substantial recreation and tourism occur in SGNP. The annual influx of tourists, based on data of 2010-11, was Indian ₹48.28 lakhs (₹48,28,000, over US\$70,000) (SGNP, 2012). The Bhuddha Pournima festival (on the full moon in the beginning of May) and other festivals draw people internationally to the SGNP Kanheri Caves. Birdwatchers, local morning walkers, and foreign as well as Indian tourists use SGNP as a green space for its recreational activities, its history, its ecosystem or simply its outdoor trails. The rising population in Mumbai has led to a decrease in open spaces, but the presence of Sanjay Gandhi National Park has provided many lucrative 'Environmental Gains'.
	Aesthetic value	Significantly positive	Local, city, national and international		This value is effectively subsumed into cultural, spiritual, tourism and other values
	Spiritual and religious value	Significantly positive	Local, city, national and international		This value is effectively subsumed into the description of recreation and tourism values above

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Cultural services	Inspiration of art, folklore, architecture, etc.	Positive	Local and city		The Kanheri Caves within SGNP are based on the geology of the region. Park regulations do not allow other artistic/festival activities within the SGNP boundary
	Social relations (e.g. fishing, grazing or cropping communities)	Positive	'Local, city and national	Valuation may be subsumed in visitor number quantification above	The natural beauty, biodiversity, culture and other attributes of SGNP are a focal point for many special interest groups (birders, botanists, etc.) as well as communal walking and other activities
	Educational and research	Positive	'Local, city, national and international	Possibly assess by travel cost methods. (PES markets may be hard or impossible to identify for this service)	SGNP hosts substantial local, national and international research activities as well as providing teaching and learning resources
Supporting services	Soil formation	Significantly positive	Local	Underpins other services, for which valuation may be possible	Substantial intact habitats build soil fertility and structure
	Primary production	Significantly positive	Local and city	Underpins other services, for which valuation may be possible	Substantial and diverse habitats have high productivity, some of which will leave the park down river and in the diets of visiting birds, etc.
	Nutrient cycling	Significantly positive	Local and city	Underpins other services, for which valuation may be possible	Substantial and diverse habitats recycle nutrients efficiently, retaining the nutrients in the park and also providing nutrient flows downstream
	Water recycling	Significantly positive	Local and city	Underpins other services, for which valuation may be possible	Substantial and diverse habitats recycle water efficiently, retaining moisture in the biota and contributing the regulating service of water regulation (hydrology)
	Photosynthesis (production of atmospheric oxygen)	Significantly positive	Local, city, national and international	Underpins other services, for which valuation may be possible	Substantial and diverse habitats have high photosynthetic activity, generating oxygen that contributes to local, national and international atmospheric contribution
	Provision of habitat	Significantly positive	Local, city, national and international	Underpins other services, for which valuation may be possible	The purpose of SGNP is to conserve characteristic wildlife and genetic diversity, of value to all geographical scales and for its inherent value. The forests are mostly of the moist deciduous type and, in general, they are dense throughout the area. The park is an example of one of the least represented biographic zones – the Malabar Coast of the Western Ghats – which forms only 0.4% of the protected area network.