# Appendix

**Methodological approaches to mangrove valuation: Where do we stand?**

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Table A1. Ecosystem service values in US$ per ha per year for mangrove ecosystems.

| **Ecosystem service** | **Example values (per ha per year)** |
| --- | --- |
| Food | Benefit transfer: US$5.75 (Witt, 2016), US$ 90 (Khaleel, 2012; Khaleel et al., 2009), US$212 (Ayanlade and Proske, 2015), US$418.07-776.40 (Clark et al., 2012), US$450 (Ullah et al., 2010), US$577-980.18 (Burgess et al., 2015) US$797 (Gunawardena, 2009), US$1,225 (Mendoza-Gonzalez et al., 2012), US$8,700 (Souza and Silva, 2011), US$23,613 (Mubarak Bin Daina et al., 2015)  Production function: US$52-105 (Islam and Ikejima, 2010), US$18,849 (Vazquez-Gonzalez et al., 2015), US$126,444 (Pascal and Bulu, 2013)  Market price: US$37 (Malik et al., 2015a), US$48.8 (Hoberg, 2011), $US49 (Giri et al., 2011; Samonte-Tan et al., 2007), US$97.90 (Janekarnkij, 2010), US$113.09 (Kairo et al., 2009), US$238 (Huxham et al., 2015), US$385-419 (Kuenzer and Tuan, 2013), US$560.55 (Otieno, 2015) |
| Water | Benefit transfer: US$212 (Ayanlade and Proske, 2015), US$1,385-6,716 (Mubarak Bin Daina et al., 2015) |
| Raw material | Benefit transfer: US$1.45 (Mendoza-Gonzalez et al., 2012), US$45.30 (Emerton and Aung, 2013), US$50 (Khaleel, 2012; Khaleel et al., 2009), US$79.50 (Interwies and Gorlitz, 2013), US$101 (Barbier, 2012b), US$110 (Ullah et al., 2010), US$212 (Ayanlade and Proske, 2015)  Production function: US$151 (Witt, 2016), US$5,100 (Christensen et al., 2008), US$1,336-9201 (Kallesoe et al., 2008), US$39,233 (Pascal and Bulu, 2013)  Market price: US$12 (Malik et al., 2015b), US$30.50 (Janekarnkij, 2010), US$35.70 (Hoberg, 2011), US$41.54 (Otieno, 2015), US$206 (Huxham et al., 2015), US$2,040 (Vo, 2013) |
| Waste treatment | Benefit transfer: US$30.80 (Interwies and Gorlitz, 2013), US$569 (Mendoza-González et al., 2012), US$660 (Khaleel, 2012)US$760 (Ullah et al., 2010), US$6,696 (Gunawardena, 2009), US$11,000 (Korovulavula et al., 2008)  Replacement cost: US$72 (Souza and Silva, 2011) |
| Climate regulation | Benefit transfer: US$2.20 (Janekarnkij, 2010), US$186 (Ayanlade and Proske, 2015), US$219 (Quoc Vo et al., 2015), US$59-6,538 (Kuenzer and Tuan, 2013), US$1,100 (Ullah et al., 2010)  Market price: US$30.50 (Barbier et al., 2011), US$44.42 (Kairo et al., 2009), US$126 (Hoberg, 2011), US$251 (Huxham et al., 2015), US$550-1,100 (Malik et al., 2015b)  Production function: US$414,411 (Pascal and Bulu, 2013)  Social cost of carbon: No per ha per year estimates published. |
| Erosion prevention | Benefit transfer: US$38.25 (Janekarnkij, 2010), US$186 (Ayanlade and Proske, 2015), US$672 (Samonte-Tan et al., 2007), US$800 (Khaleel, 2012), US$973.95 (Emerton and Aung, 2013) US$1200 (Ullah et al., 2010), US$1,340.60 (Interwies and Gorlitz, 2013)  Market price: US$395 (Huxham et al., 2015), US$660 (Quoc Vo et al., 2015), US$3,896 (Kuenzer and Tuan, 2013) |
| Moderation of extreme events | Benefit transfer: US$16 (Janekarnkij, 2010), US$40 (Ullah et al., 2010), US$639.35 (Emerton and Aung, 2013), US$1,340 (Interwies and Gorlitz, 2013), US$1,356.66-1,631 (Burgess et al., 2015)US$1,500 (Khaleel, 2012), US$1,839 (Gunawardena, 2009), US$2,000 (Ullah et al., 2010), US$3,116 (Mubarak Bin Daina et al., 2015)  Replacement cost: US$35 (Huxham et al., 2015), US$660 (Quoc Vo et al., 2015), US$694-3,767 (Malik et al., 2015b), US$1,879 (Barbier, 2012b)  Avoided cost: US$91.70 (Hoberg, 2011) |
| Maintenance of soil fertility and nutrient cycling | Benefit transfer: US$640 (Khaleel, 2012; Ullah et al., 2010) |
| Regulation of water flows | Benefit transfer: US$540 (Ullah et al., 2010), US$660 (Khaleel, 2012) |
| Maintenance of genetic diversity | Benefit transfer: US$2.43 (Witt, 2016), US$5 (Hoberg, 2011), US$19 (Samonte-Tan et al., 2007), US$100 (Ullah et al., 2010), US$168 (Ayanlade and Proske, 2015), US$200 (Khaleel, 2012; Khaleel et al., 2009) |
| Maintenance of life cycles of migratory species | Benefit transfer: US$117.14 (Janekarnkij, 2010), US$243 (Samonte-Tan et al., 2007)US$249 (Barbier, 2012b), US$425.60 (Interwies and Gorlitz, 2013), US$3,500 (Ullah et al., 2010), US$4,200 (Khaleel, 2012; Khaleel et al., 2009)  Production function: US$995-4,887 (Kallesoe et al., 2008), US$2,124 (Kuenzer and Tuan, 2013)  Market price: No per ha per year estimates published. |
| Aesthetic information | Benefit transfer: US$500 (Khaleel, 2012; Khaleel et al., 2009) |
| Information for cognitive development | Benefit transfer: US$50 (Ullah et al., 2010), US$100 (Khaleel, 2012)  Market price: US$184.40 (Hoberg, 2011), US$770.23 (Kairo et al., 2009) |
| Opportunities for recreation and tourism | Benefit transfer: US$20 (Ayanlade and Proske, 2015), US$155 (Mendoza-González et al., 2012) US$500 (Khaleel, 2012; Ullah et al., 2010), US$658 (Gunawardena, 2009), US$37,927 (Mubarak Bin Daina et al., 2015)  Market price: US$9.30 (Kairo et al., 2009), US$453.20 (Janekarnkij, 2010), US$ 2,352.15 (Souza and Silva, 2011)  Contingent valuation: US$97 (Dehghani et al., 2010)  Travel cost method: US$2,960.44-4,597.71 (Kuenzer and Tuan, 2013) |

## Table A2. Summary of ecosystem service values published for mangroves.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year values were calculated for** | **Unknown** | **1996** | **1998** | **1999** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** |
| **Total ES value** | US$11,850/ha/yr (Ullah et al. 2010), VND146,700/household/year (Tuan et al. 2014); US$10,960/ha/yr (Khaleel et al. 2009; 2012) | US$18,978/ha (Barbier 2012) |  |  |  |  | US$757.55/ha/yr (Janekarnkij 2010) |  |  | 1852.60 million PhP/ha (Padilla 2008) |
| **Provisioning services** | US$4800/ha/yr (Korovulavula et al. 2008) |  |  |  |  |  |  |  |  |  |
| **Food** | Aquatic production: US$300/ha/yr, Fishing: US$150/ha/yr (Ullah et al. 2010); Fisheries productivity: US$25,149(+-1,395 SE)/km (Aburto-Oropeza et al. 2008), Drinking water, food and raw materials: US$212/ha/yr (Ayanlade et al. 2015), Fisheries: $23,613/ha/yr (Mubarak Bin Daina et al. 2015), Fisheries: RM432.75 /household/month (Mojiol et al. 2016); Mud-crab fishing: US$5.75/ha/yr (Witt 2016); Fisheries: 0.02 million €/km²/year (Failler et al. 2015); Fisheries: US$37/ha/yr (Malik et al. 2015); Aquaculture: US$ 8,700 / ha / year (Souza and Silva 2015); Fisheries: US$44.62-68.6/household/year, Honey: US$3.6/household/year (Hussain and Badola 2010); Fishing: US$ 90/ha/yr (Khaleel et al. 2009; 2012); Food production/biological control: US$797/ha/yr (Gunawardena 2009); Mudcrabs: IDR 81,811,800/yr, Fish: IDR 440,000/yr (Susilo et al. 2016) |  |  |  | Fish: US$200,000 /yr, Crab: US$20,000/yr, Honey and wax: US$15,000/yr (2001-2010 average, Uddin et al. 2013) |  | Fisheries: US$97.9/ha/year (Janekarnkij 2010); Commercial, recreational, and subsistence fisheries harvest: $418.07 to $776.40 per ha (Clark et al. 2012) | Fisheries: US$52-105/ha/yr (Islam and Ikejima 2010); Fisheries: US$16/ha/yr, Mollusks/Echinoderms: US$33/ha/yr (Samonte-Tan et al. 2007) |  | Fisheries: 68,436.15 PhP/km2/yr (Padilla 2008), Commercial and subsistence fisheries: US$7119.51/household/yr (O’Garra 2012); Fin fish: US$113.09/ha/yr (Kairo et al. 2009); Food production: US$1225/ha/yr (Mendoza-González et al. 2012) |
| **Water** | Drinking water, food and raw materials: US$212/ha/yr (Ayanlade et al. 2015), Water purification: US$ 1385-$6716 ha/yr (Mubarak Bin Daina et al. 2015) |  |  |  |  |  |  |  |  |  |
| **Ornamental resources** |  |  |  |  |  |  |  |  |  |  |
| **Genetic resources** |  |  |  |  |  |  |  |  |  |  |
| **Medicinal resources** | Spiritual, medical and recreational benefits: US$20/ha/yr (Ayanlade et al. 2015) |  |  |  |  |  | Raw material (incl. medicinal plants): US$30.5/ha/year (Janekarnkij 2010) |  |  |  |
| **Raw material** | Livestock grazing: US$60/ha/yr, Fertilizer industry: US$50/ha/yr (Ullah et al. 2010), Drinking water, food and raw materials: US$212/ha/yr (Ayanlade et al. 2015), Timber products: RM40.85 /household/month (Mojiol et al. 2016); Beekeeping: US$0.88/ha/yr, Sustainable timber harvesting: US$0.50/ha/yr, Charcoal production: US$150/ha/yr (Witt 2016); Firewood: US$2/ha/yr, Charcoal: US$5/ha/yr, Nypa palm crafting valule: US$5/ha/yr (Malik et al. 2015); Fuelwood: US$88.34, Timber: US$20.1/household/year, Thatching material: US$2.5/household/year (Hussain and Badola 2010); Fertilizer industry: US$50/ha/yr (Khaleel et al. 2009; 2012); Total gross mangrove product (Sri Lanka): US$1,771/household/yr and US$9,201/ha/yr,  Total gross mangrove product (Thailand): US$9443-14428/household/yr and US$1336-3306/ha/yr (Kallesoe et al. 2008) | Wood and non-wood products: US$101/ha/yr (Barbier 2012) | Forestry products: US$5,100/ha/yr (1998-2001 average, Christensen et al. 2008) |  | Timber: US$400,000/yr,  Thatching materials: US$60,000/yr, Fuel wood: US$60,000/yr (2001-2010 average, Uddin et al. 2013) |  | Raw material (incl. medicinal plants): US$30.5/ha/year (Janekarnkij 2010); Timber and building material provisions: $89.59 to $101.42 per ha (Clark et al. 2012) |  |  | Timber: 279,770.44 PhP/km2/yr (Padilla 2008); Poles: US$4,328.27/ha of the plantation, Fuelwood: US$222.07/ha of the plantation (Kairo et al. 2009); Raw materials: US$1.45/ha/yr (Mendoza-González et al. 2012) |
| **Regulating services** |  |  |  |  |  |  |  |  |  |  |
| **Waste treatment** | Pollution filtration: US$260/ha/yr  Heavy metal removal: US$150/ha/yr, Chemical pollution absorption: US$350/ha/yr (Ullah et al. 2010); Water and waste treatment: 0.17 M €/km²/year (Failler et al. 2015); Wastewater treatment: US$ 72.00/ha/year (Souza and Silva 2011); Pollution filtration: US$260/ha/yr, Heavy metal removal: US$100/ha/yr, Chemical pollution absorption: US$300/ha/yr (Khaleel et al. 2009; 2012); US$66,960/km /yr (in 1994 US$) or US$11,000/ha/yr (Korovulavula et al. 2008); US$6696/ha/yr (Gunawardena 2009) |  |  |  |  |  |  |  |  | 53.83 million PhP/yr (Padilla 2008); $569/ha/yr(Mendoza-González et al. 2012) |
| **Moderation of extreme events** | Protection against cyclone and wave damage: US$2000/ha/yr (Ullah et al. 2010), Coastal protection: $3,116/ha/yr (Mubarak Bin Daina et al. 2015); Coastal protection: 0.06 million €/km²/year (Failler et al. 2015); Coastline protection: US$694-3767/ha/yr (Malik et al. 2015); Protection against Tsunami and wave damage: US$1500/ha/yr (Khaleel et al. 2009; 2012); Coastal protection: US$1839/ha/yr (Gunawardena 2009); Wave breakers: IDR 93,699,170/yr; Abrasion breakers: IDR 26,364,2000/yr (Susilo et al. 2016) | Storm protection: US$134,801/ha (Barbier 2007), Coastal protection: US$1879/ha/year (Barbier 2012) |  | Wind protection: US$177/ha (Das and Crepin 2013) |  |  | Storm protection: US$16/ha/yr (Janekarnkij 2010) |  | Erosion control and Storm protection: 23,210.74 PhP/ha/yr (Defiesta 2007) | Coastal protection: 40,000PhP/ha/yr (Padilla 2008); Coastal protection: US$95686.63/km/yr (O’Garra 2012) |
| **Regulation of water flows** | Flood control: US$500/ha/yr, Groundwater and recharge supply: US$40/ha/yr (Ullah et al. 2010); Seawater intrusion prevention: US$277/ha/yr (Malik et al. 2015), Flood control: US$600/ha/yr; Groundwater and recharge supply: US$60/ha/yr (Khaleel et al. 2009; 2012) |  |  |  |  |  |  |  |  |  |
| **Erosion prevention** | US$1200/ha/yr (Ullah et al. 2010), Erosion and climate control: US$186/ha/yr (Ayanlade et al. 2015); US$800/ha/yr (Khaleel et al. 2009; 2012); Shoreline protection: 1) US$170,100 per km of shoreline per yr (in 1994 US$) or 2) F$105 million total protection value (Korovulavula et al. 2008) |  |  |  |  |  | US$38.25 /ha/yr (Janekarnkij 2010); $597.24 to $1,791.71 per ha (Clark et al. 2010) | US$672/ha/yr (Samonte-Tan et al. 2007) | Erosion control and Storm protection: 23,210.74 PhP/ha/yr (Defiesta 2007) |  |
| **Climate regulation** | Microclimate regulation: US$1000/ha/yr  World climate regulation: US$100/ha/yr (Ullah et al. 2010), Erosion and climate control: US$186/ha/yr (Ayanlade et al. 2015); Carbon sequestration: 0.01 M €/km²/year (Failler et al. 2015); Carbon sequestration:US$550-1100/ha/yr (Malik et al. 2015); Microclimate regulation: US$800/ha/yr, World climate regulation: US$100/ha/yr (Khaleel et al. 2009; 2012) |  |  |  |  | Forestation cost (C fixation): 16,963,200 CNY/year; Carbon tax: 80,723,300 CNY/year (Zhiyun et al. 2011) | Carbon sequestration: US$2.2/ha/yr (Janekarnkij 2010) |  |  | Carbon sequestration: US$10.7/ton (Padilla 2008) ; US$44.42/ha/yr (Kairo et al. 2009) |
| **Maintenance of soil fertility** | Ecosystem function in terms of dry matter: US$150 /ha/yr, Oxygen production (20 kg/ha): US$ 40/ha/yr, Nutrient production and recycling: US$450/ha/yr (Ullah et al. 2010), Protection of biodiversity, genetic resources, nutrient cycling: US$168/ha/yr (Ayanlade et al. 2015); Nutrient cycling: US$854.68/ha (Hussain and Badola 2008); Ecosystem function in terms of dry matter: US$150/ha/yr, Oxygen production (20 kg/ha/yr): US$40/ha/yr, Nutrient production and recycling: US$450/ha/yr (Khaleel et al. 2009; 2012; 2012) |  |  |  |  |  |  |  | Litterfall function: 13,515.47 PhP/ha/yr (Defiesta 2007) |  |
| **Pollination** |  |  |  |  |  |  |  |  |  |  |
| **Biological control** | Food production/biological control: US$797/ha/yr (Gunawardena 2009) |  |  |  |  |  |  |  |  |  |
| **Supporting services** |  |  |  |  |  |  |  |  |  |  |
| **Maintenance of life cycles of migratory species** | Fish and shellfish habitat: US$2500/ha/yr, Waterfowl and other birds' habitat: US$1000/ha/yr (Ullah et al. 2010), Nursery habitat: NPV: US$0.47 and 0.57 million (3.44-18 km2 ha range) (Barbier 2007); Fisheries biomass production (nursery ground): 0.07 M /km²/year (Failler et al. 2015); Provision of nursery grounds: US$2292/ha/yr (Malik et al. 2015); Fish and shellfish habitat: US$2000/ha/yr; Waterfowl and other birds' habitat: US$1200/ha/yr, Wildlife habitat: US$1000/ha/yr (Khaleel et al. 2009; 2012); Nursery value (Thailand): US$995-4,887/ha/yr (Kallesoe et al. 2008); Nursery ground: IDR 116,065,005 (Susilo et al. 2016) | Habitat-fishery linkanges: US$249/ha/yr (Barbier 2012) |  |  |  |  | Nursery function: US$117.14/ha/year (Janekarnkij 2010); Habitat function: $331 per ha (Clark et al. 2012) | Nursery function: US$243/ha/yr (Samonte-Tan et al. 2007) | Nursery function: 36,955.16 PhP/ha/yr (Defiesta 2007) |  |
| **Maintenance of genetic diversity** | Preservation of gene pool: US$100/ha/yr (Ullah et al. 2010), Protection of biodiversity, genetic resources, nutrient cycling: US$168/ha/yr (Ayanlade et al. 2015); Biodiversity: US$2.43/ha/yr (Witt 2016); Preservation of gene pool: US$200/ha/yr (Khaleel et al. 2009; 2012) |  |  |  |  |  |  | US$19/ha/yr (Samonte-Tan et al. 2007) |  |  |
| **Cultural services** |  |  |  |  |  |  |  |  |  |  |
| **Aesthetic information** | Recreation and aesthetics: US$500/ha/yr (Khaleel et al. 2009; 2012) |  |  |  |  |  |  |  |  |  |
| **Spiritual experience** | US$20/ha/yr (Ayanlade et al. 2015) |  |  |  |  |  |  |  |  |  |
| **Opportunities for recreation and tourism** | Recreation and aesthetics: US$500/ha/yr (Ullah et al. 2010), Recreation: RM41.18 per visit (Ahmad 2009), Spiritual, medical and recreational benefits: US$20/ha/yr (Ayanlade et al. 2015), Recreation and tourism: $37,927/ha/yr (Mubarak Bin Daina et al. 2015); Ecotourism: 0.27 million €/km²/year, Touring activities: 0.13 million €/km²/year, Consumer surplus for recreational activities: 0.98 million €/km²/year (Failler et al. 2015); Tourism (including education and research): US$2352.15/ha/yr (Souza and Silva 2011); Recreation and aesthetics: US$500/ha/yr (Khaleel et al. 2009; 2012); Recreation: US$658/ha/yr (Gunawardena 2009); Tourism: Rs 25,000 in consumer surplus/person/year (Amarnath and Mouna 2016) |  |  |  | Tourism: US$42,000/yr (2001-2010 average, Uddin et al. 2013) |  | Ecotourism and recreation: US$453.2/ha/yr (Janekarnkij 2010); Recreation: $358.34 per ha (Clark et al. 2012) |  |  | Recreation value: US$97 ha/yr (Dehghani et al. 2010); Ecotourism: US$9.30/ha/yr (Kairo et al. 2009); Recreation: US$155/ha/yr (Mendoza-González et al. 2012) |
| **Inspiration for culture, art and design** | Spiritual, medical and recreational benefits: US$20/ha/yr (Ayanlade et al. 2015) |  |  |  |  |  |  |  |  |  |
| **Information for cognitive development** | Scientific research: US$50/ha/yr (Ullah et al. 2010); Research and education: 0.01 M €/km²/year (Failler et al. 2015); Scientific research: US$100/ha/yr (Khaleel et al. 2009; 2012) |  |  |  |  |  |  |  |  | Education and research: 7.5 million PhP/yr (Padilla 2008); US$770.23/ha/yr (Kairo et al. 2009) |
| **Existence/ option/ bequest value** | Existence value: US$1.65/ha/yr (Witt 2016); Bequest and existence value: 0.15 M €/km²/year (Failler et al. 2015); Option value for future medicinal use: US$157/ha/yr (Malik et al. 2015) |  |  |  |  |  | Non-use value: US$2.40/ha/yr (Janekarnkij 2010) |  |  | Bequest value: US$106.92/household/year (O’Garra 2012) |

| **Year values were calculated for** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Total ES value** | US$2,870 /ha/yr (Pernetta et al. 2013) ; $US4,684.20/ha/yr lost value of mangroves (all services) across the region (Eppink et al. 2014); Total ecosystem service value: US$1258/ha/year (Camacho Valdez et al. 2014); All ecosystem services combined  all of SE Asia: US$1,037.46/ha/yr, Brunei: US$4000.00ha/yr, Cambodia: US$500.00ha/yr, Indonesia: US$1043.48ha/yr, Malaysia: US$1268.18ha/yr, Myanmar: US$625.00ha/yr, Philippines: US$1833.33ha/yr, Thailand: US$1440.00ha/yr, Vietnam: US$533.33ha/yr, (Brander et al. 2012) |  | US$797/ha/yr (Pandey 2015) | US$3000/ha/yr (Quoc Vo et al. 2015) |  | $2,692/ha/yr (2012 international $) (Clavelle and Jylkka 2013) | US$17,426 /ac/year (Brown and Shi 2014) |  |  |
| **Provisioning services** |  |  |  |  |  | Extractive value: Tk 2,300/ha/yr (Chow 2015) |  |  |  |
| **Food** | Fruit: US$1/ha/yr, Fisheries: US$514/ha/yr, Worms: US$41/ha/yr, Wildlife: US$18/ha/yr (Pernetta et al. 2013); Commercial fisheries: US$18,849/ha/year (Vazquez-Gonzalez et al. 2015); Fisheries: US$1,287/ha/yr (Adhikari 2010) | Mangrove and coral reef fisheries: SBD$ 5500-12 100/household/yr (Warren-Rhodes et al. 2011) |  | Fisheries: US$44/ha/yr, Aquaculture: US$ 4.8/ha/yr ( Hoberg 2011); Commercial fisheries: 70kMGA: 6180 MGA/individual; 80k MGA: 14050 MGA/individual (Oleson et al. 2015); Fisheries: Range US$990.96 (less than 30% mangrove cover)-US$3248.14 (over 70% mangrove cover) (Quoc Vo et al. 2015); Fisheries: US$577-960.18ha/yr (Burgess et al. 2015); Fisheries: US$3404/household/year (Adekola et al. 2015) | Fisheries catch inside mangrove area: US$385.97-419.11/ha/yr (Kuenzer and Tuan 2013) | Subsistence fishery: US$ 79161/ha/yr; Int$US1311, Commercial fishery: US$ 47283/ha/yr; Int$US783 (Pascal and Bulu 2013) | Fish: US$ 559 /Ha/year, Honey: US$ 1.55 /ha/year (Otieno 2015), Food: 40.58 million Indian rupees/yr: 719.5 Indian rupees/ha/yr (Everard et al. 2014) | Capture fisheries - finfish: US$109/ha/yr, crustaceans: US$129/ha/yr (Huxham et al. 2015);  Willingness to accept mangrove conservation with a decrease in fishing from 15 kg/day to 5-15 kg/day or less than 5 kg/day: 123260-184400IRR/household/day or US$4.47-6.68/household/day (Mashayekhi et al. 2016); Fishing: US$2,793.13-5,504.22/household/yr  Snails: US$72.28/household/yr (Sopheak and Hoeurn 2016) | Fisheries: 10-year NPV per hectare ranging from $0-$3,839 /ha (Atkinson et al. 2016) |
| **Water** |  |  |  |  |  |  | Fresh drinking water: 2.72 million Indian rupees/yr: 482 Indian rupees/ha/yr (Everard et al. 2014) |  |  |
| **Ornamental resources** |  |  |  |  |  |  |  |  |  |
| **Genetic resources** |  |  |  |  |  |  |  |  |  |
| **Medicinal resources** | Medicine: US$173/ha/yr (Pernetta et al. 2013) |  |  |  |  |  |  |  |  |
| **Raw material** | Timber: US$73/ha/yr, Firewood: US$2/ha/yr (Pernetta et al. 2013) | SBD$ 2500-10 /household/yr (Warren-Rhodes et al. 2011) |  | US$3714/household/year (Adekola et al. 2015); US$ 4.2/ha/yr for timber, US$16.8/ha/yr for fuelwood, Apiculture: US$14.7/ha/yr (Hoberg 2011); Timber products: US$2040/ha/yr (Quoc Vo et al. 2015) | Wood raw material: US$2,765/ha/yr (Ajonina et al. 2014) | Raw materials: Non-timber, non-fish (NTNF) mangrove products: MMK44,000/ha/yr: US$45.30 /ha/yr (Emerton and Aung 2013); timber forestry product: U$12/ha/year; non-timber forestry product: US$67.5/ha/year (Interweis and Gorlitz 2013); Wood extraction: US$ 39233/ha/yr; Int$US650 (Pascal and Bulu 2013) | Firewood: US$26.60 /ha/year, Building materials: US$14.94 /ha/year (Otieno 2015), Timber and fuel wood collection: 3,544.74 Baht/Household/Year  Plan and herb collection: 4,704.62 Baht/Household/Year (Wiwatthanapornachai et al. 2014) | Natural regeneration after clear felling - profitability: $US369.91/ha (Aziz et al. 2015); Timber, fuelwood, honey: US$206/ha/yr (Huxham et al. 2015); Willingness to accept mangrove conservation with a decrease in mangrove wood collection from 10 bundles/trip to 5 bundles or 3 bundles/trip: 103924-116602 IRR/household/day or US$3.77-4.23/household/day (Mashayekhi et al. 2016); Fuelwood: US$54.81-98.02/household/yr,  Poles for construction materials: US$615.37/household/yr (Sopheak and Hoeurn 2016) |  |
| **Regulating services** |  |  |  |  |  |  |  |  |  |
| **Waste treatment** |  |  |  |  |  | US$30.80/ha/year (Interweis and Gorlitz 2013) | 8,819.89 Baht/Household/Year (Wiwatthanapornachai et al. 2014); Industrial and domestic wastewater treatment value: 119.57 million Indian rupees/yr: 21,200.35 Indian rupees/ha/yr (Everard et al. 2014) |  |  |
| **Moderation of extreme events** | Coastal protection: US$444/ha/yr, Windbreak: US$7/ha/yr (Pernetta et al. 2013) |  |  | Shoreline protection: US$91.7/ha/yr (Hoberg 2011); 1x4 yrs: 4130 MGA/individual; 1x/5 yrs: 14990 MGA/individual (Oleson et al. 2015); Storm protection/erosion: US$660/ha/yr (Quoc Vo et al. 2015); Coastal protection: US$1,356.66-1,631ha/yr (Burgess et al. 2015) |  | Disturbance regulation: NZ$4,909.81/ha/yr (Patterson and Cole 2013); Coastal protection: MMK 621,000/ha/yr: US$639.35 /ha/yr (Emerton and Aung 2013); Moderation of extreme events and Erosion prevention: US$1340.60/ha/year (Interweis and Gorlitz 2013); Coastal protection against floods: US$ 5644/ha/yr; Int$US93 (Pascal and Bulu 2013) | Coastal protection: 11,490.39 Baht/Household/Year (Wiwatthanapornachai et al. 2014), flood control: 348.40 million Indian rupees/yr: 61,773.05 Indian rupees/ha/yr (Everard et al. 2014) | Protection from storm surges: US$35/ha/yr (Huxham et al. 2015) | Coastal protection: $88-$6.1M/ha over 10 years (Atkinson et al. 2016) |
| **Regulation of water flows** |  |  |  |  |  |  |  |  |  |
| **Erosion prevention** | Sediment retention: US$66/ha/yr (Pernetta et al. 2013) |  |  | Storm protection/erosion: US$660/ha/yr (Quoc Vo et al. 2015) | US$3896/ha/yr (Kuenzer and Tuan 2013) | MMK 946,000/ha/yr: US$973.95 /ha/yr (Emerton and Aung 2013); Moderation of extreme events and Erosion prevention: US$1340.60/ha/year (Interweis and Gorlitz 2013) |  | Protection from coastal erosion: US$395/ha/yr (Huxham et al. 2015) |  |
| **Climate regulation** | Carbon sequestration: US$89/ha/yr (Pernetta et al. 2013) |  | Permanent carbon sequestration by global mangroves: $30.50/ha/yr (Barbier et al. 2011) | Carbon sequestration: mean estimate: social cost of carbon US$464,000/ha, marginal abatement cost US$950,000/ha, market price US$252/ha (Jerath 2012); US$ 126/ha/yr (Hoberg 2011); US$219/ha/yr (Quoc Vo et al. 2015) | Carbon sequestration: US$59.55-6538.79/ha/yr (Kuenzer and Tuan 2013) | US$335.50/ha/year (Interweis and Gorlitz 2013); Carbon sequestration: US$ 414411/ha/yr; Int$US6864 (Pascal and Bulu 2013) | Purify air pollution: 6,093.90 Baht/Household/Year, Carbon storage: 5,773.76 Baht/Household/Year (Wiwatthanapornachai et al. 2014); Carbon sequestration: 0.56 million Indian rupees/yr: 99.29 Indian rupees/ha/yr (Everard et al. 2014) | Carbon sequestration: US$251/ha/yr (Huxham et al. 2015) | Social cost of carbon: $56,045/ha, Regional Greenhouse Gas Initiative market: $6041/ha, International voluntary market price: $4819/ha,  Marginal abatement cost of carbon: $18793.60/ha (Jerath et al. 2016) |
| **Maintenance of soil fertility** | Oxygen production: US$3/ha/yr (Pernetta et al. 2013) |  |  |  |  |  | Nutrient storage: 7,510.48 Baht/Household/Year (Wiwatthanapornachai et al. 2014) |  |  |
| **Pollination** |  |  |  |  |  |  |  |  |  |
| **Biological control** |  |  |  |  |  |  |  |  |  |
| **Supporting services** |  |  |  |  |  |  |  |  |  |
| **Maintenance of life cycles of migratory species** | Nursery function: US$573/ha/yr (Pernetta et al. 2013) |  |  |  | Nursery value: US$2124/ha/yr (Kuenzer and Tuan 2013) | Refugia: NZ$413.46/ha/yr (Patterson and Cole 2013); Fisheries nursery and breeding habitat: MMK 1097574/ha/yr: US$1,130 /ha/yr (Emerton and Aung 2013); nursery grounds for fish: US$ 425.60/ha/year (Interweis and Gorlitz 2013) | Nursery and food habitat of aquatic animals: 7,294.07 Baht/Household/Year  Benthos, habitat: 10,844.13 Baht/Household/Year (Wiwatthanapornachai et al. 2014) | Nursery habitat: US$44.82/household/yr (Sopheak and Hoeurn 2016) |  |
| **Maintenance of genetic diversity** |  |  |  | US$5/ha/yr (Hoberg 2011) |  |  | Genetic diversity/Biodiversity source: 7,539.21 Baht/Household/Year (Wiwatthanapornachai et al. 2014) |  |  |
| **Cultural services** |  |  |  |  |  |  |  | Cultural services (tourism, education, research): US$41/ha/yr (Huxham et al. 2015) |  |
| **Aesthetic information** | Aesthetic value: US$11/ha/yr (Pernetta et al. 2013) |  |  |  |  |  |  |  |  |
| **Spiritual experience** |  |  |  |  |  |  |  |  |  |
| **Opportunities for recreation and tourism** | Ecotourism: US$43/ha/yr (Pernetta et al. 2013) |  |  | Recreation: US$-133ha/yr (Burgess et al. 2015) | Tourism: US$2960.44-4597.71/ha/yr (Kuenzer and Tuan 2013); 24,000 Ghanian cedis (US$16,000)/yr: US$160/ha/yr (Ajonina et al. 2014) |  | Recreation: 4,512.39 Baht/Household/Year  Bird watching: 5,714.11 Baht/Household/Year (Wiwatthanapornachai et al. 2014); Recreation: 3.79 million Indian rupees/yr: 671.96 Indian rupees/ha/yr (Everard et al. 2014) | Willingness to accept mangrove conservation with no recreational boating: 234375 IRR/household/day or US$8.50/household/day (Mashayekhi et al. 2016) |  |
| **Spiritual experience** |  |  |  |  |  |  |  |  |  |
| **Inspiration for culture, art and design** |  |  |  | Social cohesion: 4 people/village: 3070 MGA/individual; 6 people/village: 14990 MGA/individual (Oleson et al. 2015) |  |  |  |  |  |
| **Information for cognitive development** |  |  |  | Research and education: US$ 184.4 /ha/yr (Hoberg 2011) |  |  | Natural education: 8,843.15 Baht/Household/Year (Wiwatthanapornachai et al. 2014) |  |  |
| **Existence/ option/ bequest value** | Option value: US$51/ha/yr (Pernetta et al. 2013) |  |  | Existence value: US$ 70.2 /ha/yr (Hoberg 2011); Bequest value: 2 generations: 24420 MGA/individual; 5 generations: 56780 MGA/individual (Oleson et al. 2015) |  |  | National heritage: 11,317.94 Baht/Household/Year (Wiwatthanapornachai et al. 2014) |  |  |

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