

NSQF QUALIFICATION FILE

SUMMARY

CONTACT DETAILS OF THE BODY SUBMITTING THE QUALIFICATION FILE

Name and address of submitting body:

Ministry of Environment, Forest & Climate Change (MoEF&CC)
Indira Paryavaran Bhawan, Jor Bagh Road,
New Delhi- 110003

Name and contact details of individual dealing with the submission

Name: Ms. Urmila

Position in the organisation: Joint Director, MoEF&CC

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List of documents submitted in support of the Qualification File

- 1. Curriculum with training plan (Annexure I)**
- 2. Documentary Evidence of Need (Annexure II)**

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SUMMARY

1	Qualification Title:	Certificate course in on Valuation of ecosystem of goods and services
2	Qualification Code, if any: -	-
3	NCO code and occupation: -	-
4	Nature and purpose of the qualification (Please specify whether qualification is short term or long term):	<p>Nature of the qualification: Certificate course for capacity building of graduate students</p> <p>Purpose of the qualification: Forest ecosystems are critical habitats for diverse biological diversity and perform array of ecological services that provide food, water, shelter, aesthetic beauty, etc. Valuation of the services and goods provided by the forest ecosystem would aid in the micro level policy design for the conservation and sustainable management of ecosystems. Main objective is to value the ecosystems goods and services. This involves assessment of total economic value (TEV) of the ecosystem considering provisioning, regulating, supporting and information services provided by the ecosystem.</p> <p>Short Term</p>
5	Body/bodies which will award the qualification:	MoEF&CC
6	Body which will accredit providers to offer courses leading to the qualification:	MoEF&CC
7	Whether accreditation/affiliation norms are already in place or not, if applicable (if yes, attach a copy)	<p>Training programmes would be undertaken as part of the Green Skill Development Programme (GSDP) under the ENVIS Scheme. The courses would be run by the ENVIS Hubs (hosted by the respective State Government /UT Administration) and ENVIS Resource Partners (RPs)- (hosted by environment-related governmental and non-governmental organizations/ institutes of professional excellence) and other institutes. The assessment of the training programmes would be a regular exercise as part of the Memorandum of Cooperation (MoC) signed with ENVIS Hubs and RPs and Memorandum of Understanding (MoU) between the ENVIS Hubs/RPs and other GSDP Partners. The</p>

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		courses would also be run by the Autonomous Bodies/Institutes under the Ministry for which no MoC is required.
8	Occupation(s) to which the qualification gives access:	Forest Departments and other government bodies, Industries, Universities, Research Institutes
9	Job description of the occupation:	The course would provide an understanding of <ul style="list-style-type: none"> • the principles of ecosystem valuation with case studies • improved knowledge of the activities covered in the course and their implications on environment; • characteristics of factors that influence the environment and their adverse effects on environment; • use of monitoring techniques and data processing in the affected environment; and • the need to protect the environment from pollution and possible remedial techniques
10	Licensing requirements:	Permission from DFO/CCF, Forest Department in the States/UTs concerned
11	Statutory and Regulatory requirement of the relevant sector (documentary evidence to be provided):	-
12	Level of the qualification in the NSQF:	Level 5
13	Anticipated volume of training/learning required to complete the qualification:	The anticipated volume of training is 105 hours. Structuring of course is done to fuse all the three core components of competency like attitude/behaviors, skills and knowledge.
14	Indicative list of training tools required to deliver this qualification:	Verbal Lectures, PPT Presentations, Demonstration, Field Visits, AV presentations
15	Entry requirements and/or recommendations and minimum age:	Bachelor's degree
16	Progression from the qualification:	Master Trainer/Expert valuator of ecosystem goods & services
17	Arrangements for the Recognition of Prior learning (RPL):	There is no arrangement of RPL as of now
18	International comparability where known (research evidence to be provided):	Similar course is being offered in developed countries
19	Date of planned review of the qualification:	March 2020

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20	Formal structure of the qualification Mandatory/Optional components		
Title of component and identification code.	Mandatory/ Optional	Estimated size (learning hours)	Level
Ecosystems, basic characteristics of ecosystems, Levels of Organisation: From Species to Ecosystems, Types of ecosystems - Introduction	M	8	
Forest Ecosystems: Importance, types of forests, functioning of forest ecosystem...	M	8	
Vegetation sampling techniques – field data collection	M	6	
Maps, cartography, Geographic information system	M	6	
Spatial data – Introduction, brief introduction to Remote sensing, GIS	M	6	
Remote sensing data classification - Assessment of different land uses	M	6	
Field Data collection – Quantification of biomass (transect based quadrat sampling)	M	6	
Carbon sequestration, quantification of carbon sequestered in the terrestrial biomass	M	6	
Understanding pollination services, seed dispersal services, groundwater recharge...	M	4	
Soil–types, characterization, soil degradation, conservation and management	M	4	
Watershed, flood plains, buffer zone – treatment and management	M	8	
Understanding vegetation, hydrology, ecology and biodiversity linkages	M	4	
Quantification of Ecosystem Goods and Services	M	6	
Valuation of Goods and Services	M	4	
Regulating Services from Forest Ecosystem, Information services	M	5	
Field data collection – quantification	M	6	
Guest lectures and presentation of working group (participants)	M	6	
TOTAL		105	5

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SECTION 1 ASSESSMENT

21	<p>Body/Bodies which will carry out assessment:</p> <p>The assessments will be carried out by the evaluators of BNHS, Mumbai; IISc, Bengaluru; EMPRI, Bengaluru; EPTRI, Hyderabad; and Kerala State Council for Science, Technology & Environment, Thiruvananthapuram, at their respective locations. These evaluators would be chosen from the panel of experts who are not part of the trainers. Based on the evaluation, certificates will be issued.</p>
22	<p>How will RPL assessment be managed and who will carry it out?</p> <p>No RPL in this programme</p>
23	<p>Describe the overall assessment strategy and specific arrangements which have been put in place to ensure that assessment is always valid, reliable and fair and show that these are in line with the requirements of the NSQF.</p> <p>The assessment will be done through theory, practical and viva exams at the end of the course. Moreover, students will be assessed regularly through questionnaires on every module in the classroom.</p> <p>For practical examination, the trainers as well as course supervisors will constantly keep a vigil on the trainees. Any errors committed by the trainees will be corrected immediately; learning by doing technique will be adopted for practical assessment.</p> <p>In theory, a final examination will be conducted at the end of the course, in which 45% scoring will be considered to be as qualifying marks. The Assessments will be conducted through English/Hindi/Regional language Questionnaires. However, the invigilators (not Trainers/Supervisors) will be empowered to explain/translate the question to the trainees in their regional language, if required. The trainers will not be involved in the assessment, whatsoever, at any point.</p>

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24. Assessment evidences

Title of Component:

Outcomes to be assessed/NOSs to be assessed	Assessment criteria for the outcome												
<p>Course candidates on successful completion of the course would be able to:</p> <ul style="list-style-type: none"> • Explain the principles of ecosystem valuation with case studies • Demonstrate knowledge of the activities covered in the course and their implications on environment; • Anthropogenic activities that influence the environment and their adverse effects on environment; • use of monitoring techniques and data processing in the affected environment; and • the need to protect the environment and value of the ecosystem based on tangible benefits (and also other ecosystem services) 	<p>By conducting Evaluation Test- practical exam, skill test (preparation & quality assessment, techniques implemented) and written test</p>												
<p>Means of assessment 1 Assignments (end of each unit), mid-term exam and final exam</p>													
<p>Means of assessment 2 Presentation of successful case studies across the globe. Short term project – case study</p>													
<p>Pass/Fail Candidates who score more than 45 will be given certificate with grades Total marks: 100 Grades are assigned: > 95= A+, 95-95= A, 75-85= B+, 65-75=B, 55-65=C, 45-55=D and < 45 no certificate</p>													
<table border="1"> <tr> <td>Assignments</td> <td>15</td> </tr> <tr> <td>Attendance and Participation in interactive sessions:</td> <td>15</td> </tr> <tr> <td>Presentation of Case study</td> <td>15</td> </tr> <tr> <td>Project Work</td> <td>15</td> </tr> <tr> <td>Mid Term Exam:</td> <td>20</td> </tr> <tr> <td>Final Exam</td> <td>20</td> </tr> </table>	Assignments	15	Attendance and Participation in interactive sessions:	15	Presentation of Case study	15	Project Work	15	Mid Term Exam:	20	Final Exam	20	
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Mid Term Exam:	20												
Final Exam	20												

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SECTION 2

25. EVIDENCE OF LEVEL

OPTION A

Title/Name of qualification/component: Certificate course in Valuation of ecosystem of goods and services Level: 5			
NSQF Domain	Outcomes of the Qualification/Component	How the outcomes relate to the NSQF level descriptors	NSQF Level
Process	<p>Person trained under this scheme would be able to perform a job which will require routine and predictable activities pertaining to the valuation of ecosystem (forest, wetlands) goods and services. The trainees will be taught basic knowledge about ecosystem valuations based on data compilation pertaining to provisioning services, information services and support services. This would involve field data collection, quantifications, compilation from literatures and techniques in economic assessment. Participants will be trained in the field data collections, statistical analyses techniques and the standard ecosystem valuation protocol.</p>	<ul style="list-style-type: none"> • The trained person would be able to compute NPV (Net Present Value) of trees, ecosystems which are required for EIA – Environmental Impact assessment. • Trainee person could work as consultants (independent) or as qualified professionals in the government agencies to assist in the evaluation of EIA reports, etc. • The person can be an integral part of Environmental Impact Assessment (EIA) implementation team and also the Environment appraisal committees. 	
Professional knowledge	<p>Basic knowledge of ecosystem, ecosystem functions, ecosystem goods and services, understanding of unplanned developmental activities on the ecosystem integrity, ecosystem approaches in the sustainable management of ecosystems.</p> <p>Registered participants will be trained with hands on sessions – data compilation, analysis, spatial data analyses, understanding spatial patterns of temporal changes, statistical analyses, data visualization and simulation of likely changes with</p>	<ul style="list-style-type: none"> • The trained person will have enough knowledge about the ecosystems, ecosystem functions, valuation of ecosystem goods and services, ecological economics. The trained person will be an asset to any organization working on green GDP, green economics, ecological economics, environmental economics, sustainable development, Environmental impact assessment, carrying capacity assessment. 	

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Title/Name of qualification/component: Certificate course in Valuation of ecosystem of goods and services			
Level: 5			
NSQF Domain	Outcomes of the Qualification/Component	How the outcomes relate to the NSQF level descriptors	NSQF Level
	and without developmental activities, ecosystem valuation techniques. .		
Professional skill	<p>Demonstrate the ability to collect field data, data analyses, spatial data visualization, ecological valuation and would be able to recall and demonstrate practical skill, routine and repetitive in similar domains –</p> <p>This training programme is combination of theory and practical with a focus on learning and scope for employability. In addition to this, candidates will have additional technical skills for applying geo-informatics in natural resources prudent management.</p> <p>Major portion of the course will be hands on training – field data collection, data analyses, etc. through which trainee can understand how to use all knowledge practically on field. Also enough time will be given to practice on use of latest technologies.</p>	<ul style="list-style-type: none"> The trained person will be able to collect data from the field using basic technologies for spatial data collection with attribute information and data management. This will enable them to be part of academic institutions, NGO's, forest department, wildlife research NGO's and EIA teams and also the trainee would have the capability to function as independent consultant with these acquired the state of the art knowledge of geo-informatics, valuation techniques and would aid in the healthy nation development through optimal resources management 	
Core skill	Sensible professional with the ability to communicate, skills in ecological assessment and valuation techniques.	<ul style="list-style-type: none"> The core skill enhanced under this training is effective communication, basic understanding of ecosystem, ecosystem functions, valuation of goods and services, green economics, and usage of appropriate technology - geoinformatics. 	
Responsibility	<p>Under close supervision some responsibility of own work within defined limit –</p> <p>With the knowledge about valuation of goods and services, green economics, and usage of appropriate technology - geoinformatics</p>	<ul style="list-style-type: none"> PG Students who undergo internship would be able to take up research career Unemployed graduates would be able to take up jobs in research organization, NGOs, EIA teams 	

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Title/Name of qualification/component: Certificate course in Valuation of ecosystem of goods and services			
Level: 5			
NSQF Domain	Outcomes of the Qualification/Component	How the outcomes relate to the NSQF level descriptors	NSQF Level
		with responsibility under close supervision.	

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SECTION 3

EVIDENCE OF NEED

26	<p>What evidence is there that the qualification is needed? What is the estimated uptake of this qualification and what is the basis of this estimate?</p> <table border="1"><thead><tr><th data-bbox="316 501 555 584">Basis</th><th data-bbox="560 501 1353 584">In case of other Awarding Bodies (Institutes under Central Ministries and states departments)</th></tr></thead><tbody><tr><td data-bbox="316 591 555 2040">Need of the qualification</td><td data-bbox="560 591 1353 2040"><p>Study of environmental literacy in Bangalore reveals of poor environment literacy (3.5%, based on sampling of 2000 households spread across all wards). Following publications highlight the need for capacity building</p><p>BOOKS</p><ol style="list-style-type: none">1. Ramachandra T V, M D Subash Chandran, Joshi N V, 2017. Carrying capacity of Uttara Kannada district (in Kannada), Sri Bagvatsad Publications ®, Sri Sonda Swarnavalli Mahasamsthana, Sirsi 5813362. Ramachandra T V and Subash Chandran M D, 2012, Ecology and Environment, (Developed under HRD Project on Pedogogy, Co-ordinated by IITK)3. Ramachandra T.V., Subash Chandran M D., Gururaja K V and Sreekantha, 2007. Cumulative Environmental Impact Assessment, Nova Science Publishers, New York.4. Ali, Sameer, G. R. Rao, Divakar K. Mesta, Sreekantha, Mukri Vishnu, M. D. Subash Chandran, K. V. Gururaja, N. V. Joshi, and T. V. Ramachandra. <i>Ecological Status of Sharavathi Valley Wildlife Sanctuary</i>. Prism Books Pvt Ltd., Bangalore, 2007<p>Journal articles:</p><ol style="list-style-type: none">5. Ramachandra T. V., Divya Soman, Ashwath D. Naik and M. D. Subash Chandran, 2017. Appraisal of Forest Ecosystems Goods and Services: Challenges and Opportunities for Conservation, <i>Journal of Biodiversity</i>, 8(1): 12-33 (2017), DOI: http://10.1080/09766901.2017.13461606. Ramachandra T V, 2016. Valuation of goods and services from forest ecosystem of Uttara Kannada, Central Western Ghats, <i>ENVIS Bulletin Himalayan Ecology</i>, 24 (ISSN: 0971-7447): 3-277. Ramachandra T.V., Boominathan, M. and Subash Chandran M.D, 2011. Valuation of bivalves of Aghanashini estuary, Indian west coast, <i>NeBIO</i> (2011) Vol. 2(1) [http://nebio.in/?p=37]8. Ramachandra T.V., Rajinikanth R. and Ranjini V.G. 2005. Economic valuation of wetlands, <i>Journal of Environmental Biology</i>, 26(3):439-447.</td></tr></tbody></table>	Basis	In case of other Awarding Bodies (Institutes under Central Ministries and states departments)	Need of the qualification	<p>Study of environmental literacy in Bangalore reveals of poor environment literacy (3.5%, based on sampling of 2000 households spread across all wards). Following publications highlight the need for capacity building</p> <p>BOOKS</p> <ol style="list-style-type: none">1. Ramachandra T V, M D Subash Chandran, Joshi N V, 2017. Carrying capacity of Uttara Kannada district (in Kannada), Sri Bagvatsad Publications ®, Sri Sonda Swarnavalli Mahasamsthana, Sirsi 5813362. Ramachandra T V and Subash Chandran M D, 2012, Ecology and Environment, (Developed under HRD Project on Pedogogy, Co-ordinated by IITK)3. Ramachandra T.V., Subash Chandran M D., Gururaja K V and Sreekantha, 2007. Cumulative Environmental Impact Assessment, Nova Science Publishers, New York.4. Ali, Sameer, G. R. Rao, Divakar K. Mesta, Sreekantha, Mukri Vishnu, M. D. Subash Chandran, K. V. Gururaja, N. V. Joshi, and T. V. Ramachandra. <i>Ecological Status of Sharavathi Valley Wildlife Sanctuary</i>. Prism Books Pvt Ltd., Bangalore, 2007 <p>Journal articles:</p> <ol style="list-style-type: none">5. Ramachandra T. V., Divya Soman, Ashwath D. Naik and M. D. Subash Chandran, 2017. Appraisal of Forest Ecosystems Goods and Services: Challenges and Opportunities for Conservation, <i>Journal of Biodiversity</i>, 8(1): 12-33 (2017), DOI: http://10.1080/09766901.2017.13461606. Ramachandra T V, 2016. Valuation of goods and services from forest ecosystem of Uttara Kannada, Central Western Ghats, <i>ENVIS Bulletin Himalayan Ecology</i>, 24 (ISSN: 0971-7447): 3-277. Ramachandra T.V., Boominathan, M. and Subash Chandran M.D, 2011. Valuation of bivalves of Aghanashini estuary, Indian west coast, <i>NeBIO</i> (2011) Vol. 2(1) [http://nebio.in/?p=37]8. Ramachandra T.V., Rajinikanth R. and Ranjini V.G. 2005. Economic valuation of wetlands, <i>Journal of Environmental Biology</i>, 26(3):439-447.
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		<p>9. Ramachandra T V, Subash Chandran M D, Joshi N V, Rakhi Raj, Prakash N Mesta, sumesh Dudani, 2013. Valuation of Estuarine Ecosystem, Uttara Kannada District, Karnataka, Sahyadri Conservation Series 27, ENVIS Technical Report 45, ENVIS, Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560012</p> <p>10. Ramachandra T V, Subash Chandran M D, Joshi N V, Ganesh Hegde, Gautham Krishnadas, 2013, Sustainable energy alternatives for Uttara Kannada, Sahyadri Conservation Series 26, ENVIS Technical Report 58, ENVIS, Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560012</p> <p>11. Ramachandra T V, Subash Chandran M D, Joshi N V, Divya Soman, Ashwath D Naik, Prakash N Mesta, 2013. Valuation of goods and services from forest ecosystem of Uttara Kannada, Central Western Ghats, Sahyadri Conservation Series 25, ENVIS Technical Report: 44, Energy & Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560 012.</p> <p>12. Ramachandra T V, Subash Chandran M D, Bharath Settur, Deepthi Hebbale, Prakash Mesta, Rajasri Ray, Sudarshan P. Bhat, Asulabha K S, Sincy Varghese, Durga Madhab Mahapatra, Harish R. Bhat, Vinay S., Vishnu D Mukri, Gouri Kulkarni, Bharath H. Aithal, 2016. My Village Biodiversity: Documentation of Western Ghats Biodiversity through Network of Students and Teachers, Sahyadri Conservation Series 61, ENVIS Technical Report 113, Environmental Information System, CES, Indian Institute of Science, Bangalore 560012</p>	
	Industry Relevance	The curriculum/course syllabus has been jointly prepared by the Scientists/Experts in the institutions/Govt. Departments viz. BNHS, Mumbai; EMPRI, Bengaluru; IISc, Bengaluru; Kerala State Council for Science, Technology & Environment, Thiruvananthapuram; and EPTRI, Hyderabad, undertaking the course in their respective locations.	
	Usage of the qualification	This course has been designed under GSDP for the first time.	
	Estimated uptake	An uptake of 25 students at each location is envisaged.	

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27	<p>Recommendation from the concerned Line Ministry of the Government/Regulatory Body. To be supported by documentary evidences.</p> <p>NA</p>
28	<p>What steps were taken to ensure that the qualification(s) does (do) not duplicate already existing or planned qualifications in the NSQF? Give justification for presenting a duplicate qualification</p> <p>National Qualifications Register was searched to assess if there was any similar qualification and no overlap was found with the existing qualifications.</p>
29	<p>What arrangements are in place to monitor and review the qualification(s)? What data will be used and at what point will the qualification(s) be revised or updated? Specify the review process here</p> <p>Feedback would be taken from independent experts, students and teachers regarding the course content, structure and timeline of the programme. Feedback will also be taken from the Centres conducting the course. Changes suggested will be assessed by the Ministry before incorporating them in the curriculum. Next review will be done in March 2020.</p>

SECTION 4

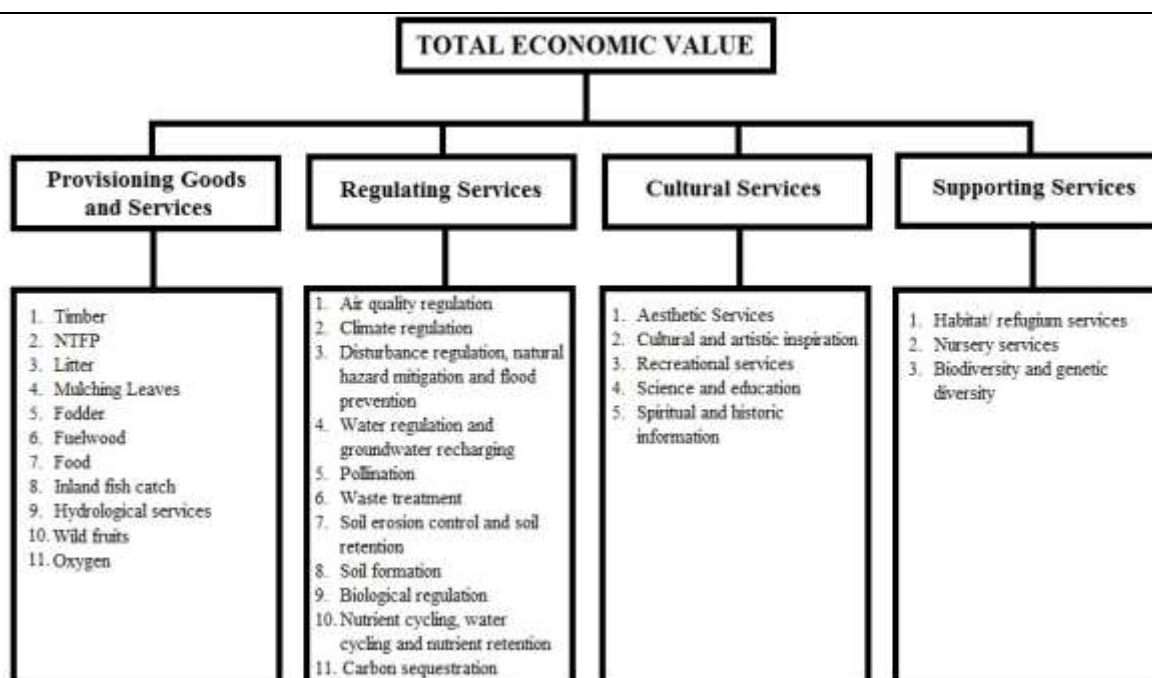
EVIDENCE OF PROGRESSION

30	<p>What steps have been taken in the design of this or other qualifications to ensure that there is a clear path to other qualifications in this sector? <i>Show the career map here to reflect the clear progression</i></p> <p>Research Assistant-On the Job Training - Master Trainer-Consultant</p>
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Curriculum with training plan

GSDP: Certificate course on Valuation of ecosystem goods and services

Forest ecosystems are critical habitats for diverse biological diversity and perform array of ecological services that provide food, water, shelter, aesthetic beauty, etc. Valuation of the services and goods provided by the forest ecosystem would aid in the micro level policy design for the conservation and sustainable management of ecosystems. Main objective is to value the ecosystems goods and services. This involves assessment of total economic value (TEV) of the ecosystem considering provisioning, regulating, supporting and information services provided by the ecosystem.



Course Schedule

Day 1 and 2	Ecosystems, basic characteristics of ecosystems, Levels of Organisation: From Species to Ecosystems, Types of ecosystems - Introduction Forest Ecosystems: Importance, types of forests, functioning of forest ecosystem...
Day 2	Vegetation sampling techniques – field data collection
Day 3	Maps, cartography, Geographic information system
Day 4	Spatial data – Introduction, brief introduction to Remote sensing, GIS
Day 5	Remote sensing data classification - Assessment of different land uses

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Day 6	Field Data collection – Quantification of biomass (transect based quadrat sampling)
Day 7	Carbon sequestration, quantification of carbon sequestered in the terrestrial biomass
Day 7	Understanding pollination services, seed dispersal services, groundwater recharge...
Day 8	Soil – types, characterization, soil degradation, conservation and management
Day 9	Watershed, flood plains, buffer zone – treatment and management
Day 10	Understanding vegetation, hydrology, ecology and biodiversity linkages
Day 11	Quantification of Ecosystem Goods and Services
Day 12	Valuation of Goods and Services
Day 13	Regulating Services from Forest Ecosystem, Information services
Day 14	Field data collection – quantification
Day 15	Guest lectures and presentation of working group (participants)

Valuation of Ecosystem Goods and Services: Framework

Sector: 1) Forests 2) Estuarine Ecosystem

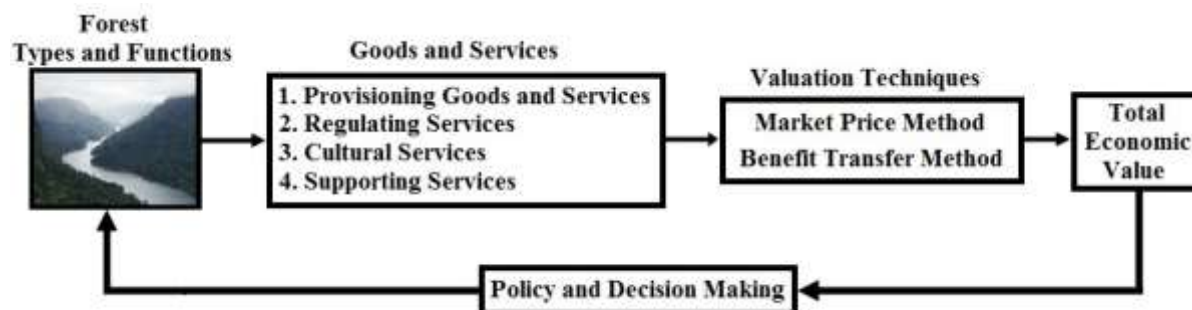


Fig. 1. Framework for valuation of goods and services from forest ecosystem

Fig. 1 outlines the method adopted for valuing forest ecosystems (taluk wise) in a district. The work entails:

- i. Assessment of different land uses in the district:* This is done considering remote sensing data of space borne sensors (IRS P6) with spatial resolution of 5.8m. The remote sensing data were geo-referenced, rectified and cropped pertaining to the study area. Geo-registration of remote sensing data has been done using ground control points collected from the field using pre calibrated GPS (Global Positioning System) and also from known points (such as road intersections, etc.) collected from geo-referenced topographic maps published by the Survey of India (1:50000, 1:250000).

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Remote sensing data analysis involved i) generation of False Colour Composite (FCC) of remote sensing data (bands – green, red and NIR). This helped in locating heterogeneous patches in the landscape; ii) selection of training polygons (these correspond to heterogeneous patches in FCC) covering 15 percent of the study area and uniformly distributed over the entire study area; iii) loading these training polygons co-ordinates into pre-calibrated GPS; vi) collection of the corresponding attribute data (land use types) for these polygons from the field. GPS helped in locating respective training polygons in the field; iv) supplementing this information with Google Earth (<http://googleearth.com>); and v) 60 percent of the training data has been used for classification, while the balance is used for validation or accuracy assessment. Land use analysis was carried out using supervised pattern classifier - Gaussian maximum likelihood algorithm based on probability and cost functions (Ramachandra et al. 2012, 2016a). Accuracy assessment to evaluate the performance of classifiers was done with the help of field data by testing the statistical significance of a difference, computation of kappa coefficients and proportion of correctly allocated cases. Statistical assessment of classifier performance based on the performance of spectral classification considering reference pixels is done which include computation of kappa (κ) statistics and overall (producer's and user's) accuracies.

- ii. ***Quantification of Goods and Services:*** Compilation of data from primary (field investigations) and secondary sources (government agencies, published scientific literatures in peer reviewed journals).
- iii. ***Valuation of Goods and Services:*** Various functions of forests are the results of interaction between structure and processes, which may be physical (for example, infiltration of water, sediment movement), chemical (for example, reduction, oxidation) or biological (for example, photosynthesis and de-nitrification). Further, various goods and services obtained from the functioning of forest ecosystem were classified as provisioning goods and services, regulating services, cultural services and supporting services. Two approaches of valuation are used for the computation of TEV of forest ecosystem, namely: ‘market price’ method and ‘benefit transfer’ method of valuation.
 - a. ***Market Price:*** This technique estimates the economic values of those goods and services that are bought and sold in established markets. Valuation of provisioning

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goods and services has been done through ‘market price’ valuation. For those goods and services which do not pass through market transaction process (viz. water utilization for irrigation and power generation, ecological water, wild fruits) well adopted technique of proxy/shadow prices have been used.

- b. Benefit Transfer:* This technique involves the application of value estimates, functions, data and/or models developed in one context to address a similar resource valuation question in an alternative context. The cost of surveys in terms of time and money could be avoided by this approach. Benefit transfer method of valuation is used to compute the value of regulating, cultural and supporting services. Some of the components of these services were computed based on unit values of those services for different types of forest based on the discussion and interview with subject experts.
- iv. Quantification of Goods and Services:*The detailed procedure of valuation of different components of ecosystem services is discussed below:

 - a. Provisioning Services from Forest Ecosystem:*Goods derived from the forests are quantified as follows:

 - *Timber:*Timber is an important component of value on forestland properties. In many cases, the value of the timber can be several times the value of the land. Timber includes rose wood, teak wood, jungle wood, etc. Timber is mainly prominent in deciduous forest while it is found in less amount in Evergreen forest patches. Plantation forest is mainly abundant in timber producing trees like Acacia, Teak etc. Industrial produce is also present from the forest which includes round wood, soft wood, match wood etc.
 - *Non Timber Forest Product:*The data on the harvesting of non-timber forest product is obtained from the Forest department. The total value of NTFP includes the value of a) NTFPs extracted by Forest Department, b) NTFPs collected by households, c) bamboo extracted by the Forest department, d) annual bamboo productivity in the forest (NABARD 2015; WCPM 2016), e) cane extracted by Forest department and f) annual cane productivity in the forest .
 - *Litter:* Litter is used as manure in horticulture and agriculture fields. Quantity of litter productivity per year for different taluks is based on earlier work.
 - *Mulching Leaves:*Mulching leaves is used as manure in arecanut gardens. Per year requirement of mulching leaves from forest can be quantified by the area of

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arecanut gardens in each taluka multiplied by the minimum quantity of mulching leaves per hectare of arecanut garden.

- *Fodder*: Total value of fodder supplied from forest can be quantified by using the data from literature on herb layer productivity in different types of forests, extent of different types of forest and unit market price of the fodder in the district.
- *Medicinal Plants*: Various medicinal plants used by the local people can be identified from studies and the value of medicinal plants per unit area of forest area extrapolated to different types of forest in the district.
- *Fuel Wood*: The total value of fuel wood includes the value of fuel wood used for domestic purpose, that is, for cooking and water heating and also the value of fuel wood used for various industrial and commercial purposes like jaggery making, areca processing, cashew processing, restaurants and bakery, parboiling, cremation, etc. The quantity of fuel wood for domestic usage in different locations of the district can be obtained from studies and the quantity of fuel wood required for various other purposes based on field experiments.
- *Food*: 22 varieties of food products derived from forest were identified and the value of food extracted per unit area of forest obtained from literature (Hebbar et al. 2010; PSP 2016; SCIL 2015) was extrapolated to the total forest area in the taluk. Also, the household honey collection which is an important provisioning service from forest was quantified (Ramachandra et al. 2012) for all talukas and valued.
- *Inland Fish Catch*: Inland fishing is an important economic activity and a determinant of nutritional requirement of large number of people. Inland fishing happens in rivers, rivulets, streams, reservoirs, lakes, etc. which are inseparable part of the forest area in the district. The quantities of inland fish catch in different taluks are obtained from Fisheries Department and the economic value of it is determined.
- *Hydrological Services*: Most of the water resources come from the forested catchments. Hydrological services is quantified by the quantity of domestic water utilization, water for irrigation purpose (Ramachandra et al. 1999, 2012, 2016a), water for industrial use and water used for power generation (5 hydro power stations and 1 nuclear power station). The quantity of water required for

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sustenance of forest ecosystem i.e. ecological water available for different types of forest is quantified.

- Quantity of Ecological Water = Run off Coefficient x Annual Precipitation x Forest Area.
- *Wild Fruits*: Information on various wild fruits can be obtained from literature. The productivity of wild fruits can be estimated based on studies, transect survey data in different types of forest and information from local people. For economic valuation of wild fruits proxy price (in comparison with the price of fruits collected as NTFP) is used.
- *Oxygen Provision*: Value of oxygen provision from forests is quantified based on the values of oxygen production per hectare of subtropical forest.

These provisioning services are valued based on market price method.

b. Regulating Services from Forest Ecosystem: Regulating services provide many direct and indirect benefits to humans. The maintenance of the Earth's biosphere in a hostile cosmic environment depends on a delicate balance between these regulating services (de Groot et al. 2002). However, regulating services unlike provisioning services poses much greater challenges in valuation. Though regulating services are seldom marketed, the economy heavily depends upon the utility of these services.

The value of carbon sequestration has both flow and stock value. The productivity of biomass per hectare per year and the volume of standing biomass for different types of forests of a particular location can be obtained from literature. The volume of carbon is computed with the assumption that 50 percent of the dry biomass contains carbon (Seema and Ramachandra 2010). The value of carbon sequestration was calculated by considering 10 Euros per tonne of CO₂ (EEC 2012). The total value of carbon sequestration per year for different taluks includes the value of per year increment in the carbon sequestration and per year value of interest (considering 5% interest rate) over the total stock/ volume of carbon in the forest till date.

c. Cultural Services from Forest Ecosystem: Forest has a high cultural value; the main reason can be attributed to the aesthetic beauty, recreational benefit and Kan forest which are the sacred groves present in the district. Sacred groves are communally-protected forest fragments with significant religious connotations. Further, recreational benefits provided by the forest include gaming, walking, hunting etc.

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Aesthetic beauty of the forest is valuable, the presence of waterfalls and caves adds to the aesthetic value in the district. Science and educational value provided by the forest are also indispensable. The unit value for the services, are derived from studies and also in consultation with subject experts.

- d. *Supporting Services From Forest Ecosystem:* The supporting service provided by the forest includes the habitat/refugium function, nursery function and biodiversity and genetic diversity function. The forest provides living space for a large number of plants and animals thus, playing an important role in the refugium function. It also acts as a nursery for immense plants and animals. The forest also serves as a store house of information. To maintain the viability of this genetic library, the maintenance of natural ecosystems as habitats for wild plants and animals is essential. The unit value of habitat/ refugium function and nursery function will be derived from literature and the unit value of biodiversity and genetic diversity estimated based on the flow value of selected provision services that represent the least value stock of biodiversity and genetic diversity.

Total Economic Value

The total economic value (TEV) of forest ecosystem is obtained by aggregating provision goods and services (provisioning, regulating, cultural and supporting services). The total economic value that has been calculated for one year is divided by the area of forest in each taluk to obtain the per hectare value of forest in respective taluk.