Models for Impact Predictions

Annex V.1

Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction:

Air Environment

(Also Please Refer CPCB Guidelines for Air Quality Modelling PROBES/70/1997-98)

Model	Application	Remarks
ISCST 2	Appropriate for point, area and line sources Applicable for flat or rolling terrain Transport distance up to 50 km valid Computes for 1 hr to annual averaging periods	Can take up to 99 sources Computes concentration on 600 receptors in Cartesian or polar co-ordinate system Can take receptor elevation Requires source data, meteorological and receptor data as input.
PTMAX	Screening model applicable for a single point source Computes maximum concentration and distance of maximum concentration occurrence as a function of wind speed and stability class	Requires source characteristics No met data required Used mainly for ambient air monitoring network design
PTDIS	Screening model applicable for a single point source Computes maximum pollutant concentration and its occurrence for the prevailing meteorological	Requires source characteristics Average met data (wind speed, temperature, stability class etc.) required Used mainly to see likely impact of a single source

	conditions	
MPTER	Appropriate for point, area and line sources Applicable for flat or rolling terrain Transport distance up to 50 km valid Computes for 1 hr to annual averaging periods Terrain adjustment is possible	Can take up to 250 sources Computes concentration at 180 receptors up to 10 km Requires source data, meteorological data and receptor co-ordinates

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Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction

Model	Application	Remarks
CTDM PLUS (Complex Terrain Dispersion Model)	Point source steady state model, can estimate hourly average concentration in isolated hills/array of hills	Can take maximum 40 stacks and computes concentration at maximum 400 receptors Does not simulate calm met conditions Hill slopes are assumed not to exceed 15 degrees Requires source, met and terrain characteristics and receptor details
UAM (Urban Air shed Model)	3-D grid type numerical simulation model Computes O_3 concentration under short term episodic conditions lasting for 1 or 2 days resulting from NOx and VOCs Appropriate for single urban area having significant O_3 problems	
RAM (Rural Air shed Model)	Steady state Gaussian plume model for computing concentration of relatively	Suitable for flat terrain Transport distance less than 50 kms

	stable pollutants for 1 hr to 1 day averaging time } Applicable for point and area sources in rural and urban setting	
} CRESTER	} Applicable for single point source either in rural or urban setting } Computes highest and second highest concentration for 1hr, 3 hr, 24 hr and annual averaging times } Tabulates 50 highest concentrations for entire year for each averaging times	} Can take up to 19 stacks simultaneously at a common site } Unsuitable for cool and high velocity emissions } Do not account for tall buildings or topographic features } Computes concentration at 180 receptor, circular wing at five downwind ring distance 36 radials } Require source, and met data

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Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Air Environment

Model	Application	Remarks
• OCD (Offshore and coastal Dispersion Model)	• It determines the impact of offshore emissions from point sources on the air quality of coastal regions • It incorporates over water plume transport and dispersion as well as changes that occur as the plume crosses the shore line • Most suitable for over water sources where onshore receptors are below the lowest shore height	• Requires source emission data • Require hourly met data at offshore and onshore locations like water surface temperature over water air temperature relative humidity etc.
• FDM (Fugitive Dust Model) for Fugitive emissions estimation	• Suitable for emissions from fugitive dust sources • Source may be point, area or line (up to 121 source) • Require particle size classification max. up to 20 sizes • Computes concentrations for 1hr, 3hr, 8hr, 24hr or annual average periods	• Require dust source particle sizes • Source co-ordinates for area sources, source height and geographic details • Can compute concentration at max. 1200 receptors • Require met data (wind direction, speed, temperature, mixing height and stability class) • Model do not include buoyant point sources, hence no plume rise algorithm
• RTDM (Rough Terrain Diffusion Model)	• Estimates GLC is complex/rough (or flat) terrain in the vicinity of one or more co-located point sources • Transport distance max. up to 15 km • Can be used as screening model beyond 15 km to up to 50 km • Computes for 1 to 24 hr. or annual average concentrations	• Can take up to 35 co-located point sources • Require source data and hourly met data • computes concentration at maximum 400 receptors • Suitable only for non reactive gases • Do not include gravitational effects or depletion mechanism such as rain / wash out, dry deposition

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Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Air Environment

Model	Application	Remarks
CDM (Climatological Dispersion Model)	It is a climatological steady state GPM for determining long term (seasonal or annual) arithmetic average pollutant concentration at any ground level receptor in an urban area	Suitable for point and area sources in urban region, flat terrain Valid for transport distance less than 50 kms Long term averages : one month to one year or longer
PLUVUE-II (Plume Visibility Model)	Applicable to assess visibility impairment due to pollutants emitted from well defined point sources It is used to calculate visual range reduction and atmospheric discoloration caused by plumes It predicts transport, atmospheric diffusion, chemical conversion, optical effects, surface deposition of point source emissions	Require source characteristics, met data and receptor co-ordinates & elevation Require atmospheric aerosols (background & emitted) characteristics, like density, particle size Require background pollutant concentration of SO_4^-, NO_3^{--}, NOx, NO_2, O_3, SO_2 and deposition velocities of SO_2, NO_2 and aerosols
MESO-PUFF II (Meso scale Puff Model)	It is a Gaussian, Variable trajectory, puff superposition model designed to account for spatial and temporal variations in transport, diffusion, chemical transformation and removal mechanism encountered on regional scale. Plume is modelled as a series of discrete puffs and each puff is transported independently Appropriate for point and area sources in urban areas Regional scale model.	Can model five pollutants simultaneously (SO_2, SO_4, NOx, HNO_3 and NO_3) Require source characteristics Can take 20 point sources or 5 area sources For area source-location, effective height, initial puff size, emission is required Computes pollutant concentration at max. 180 discrete receptors and 1600 (40 x 40) girded receptors Require hourly surface data including cloud cover and twice a day upper air data (pressure, temp., height, wind speed, direction)

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Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Noise Environment

Model	Application	Remarks
FHWA (Federal Highway Administration)	Noise Impact due to vehicular movement on highways	
Dhawani	For predictions of impact due to group of noise sources in the industrial complex (multiple sound sources)	Model developed at NEERI, Nagpur
Hemispherical sound wave propagation Air Port: Federal Aviation Administration EPA United States Air Force	For predictive impact due to single noise source For predicting impact of traffic on airport and rail road	

Annex V.2

Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Water Environment

Name	Applications	Remarks
QUAL-II E	Wind effect is insignificant, vertical disperse effects insignificant applicable to streams Data required Deoxygenation coefficients, re-aeration coefficients for carbonaceous, nitrogenous and benthic substances, dissolved oxygen deficit	Steady state or dynamic model
	The model is found excellent to generate water quality parameters Photosynthetic and respiration rate of suspended and attached algae	
	Parameters measured up to 15 components can be simulated in any combination, e.g. ammonia, nitrite, nitrate, phosphorous, carbonaceous BOD, benthic oxygen demand, DO, coli forms, conservative substances and temperature	
DOSAG-3, USEPA : (1-D) RECEIV-II, USEPA	Water quality simulation model for streams & canal A general water quality model	Steady-state
Explore-I, USEPA	A river basin water quality model	Dynamic, simple hydrodynamics
HSPF, USEPA	Hydrologic simulation model	Dynamic, simple hydrodynamics
RECEIVE-II, USEPA	A general dynamic planning model for water quality management	

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Name	Applications	Remarks
Stanford watershed model	- This model simulates stream flows once historic precipitation data are supplied - The major components of the hydrologic cycle are modelled including interception, surface detention, overland flow, inflow, groundwater, evapo-transpiration and routing of channel flows, temperature, TDS, DO, carbonaceous BOD coliforms, algae, zoo plankton, nitrite, nitrate, ammonia, phosphate and conservative substances can be simulated	
Hydrocomp model	- Long-term meteorological and wastewater characterisation data is used to simulate stream flows and stream water quality	Time dependant (Dynamic)
Storm water Management model (SWMM)	- Runoff is modelled from overland flow, through surface channels, and through sewer network Both combined and separate sewers can be modelled. - This model also enables to simulate water quality effects of storm water or combined sewer discharges. This model simulates run-off resulting from individual rainfall events	Time dependant
Battelle Reservoir model	- Water body is divided into segments along the direction of the flow and each segment is divided into number of horizontal layers. The model is found to generate excellent simulation of temperature and good prediction of water quality parameters. - The model simulates temperature, DO, total and benthic BOD, phyto plankton, zoo plankton, organic and inorganic nitrogen, phosphorous, coli form bacteria, toxic substances and hydrodynamic conditions	Two dimensional multi-segment model
TIDEP (Turbulent diffusion temperature model reservoirs)	- Horizontal temperature homogeneity Coefficient of vertical turbulent diffusion constant for change of area with depth negligible coefficient of thermal exchange constant - Data required Wind speed, air temperature, air humidity, net incoming radiation, surface water temperature, heat exchange coefficients and vertical turbulent diffusion coefficients	Steady state model
BIOLAKE	- Model estimates potential fish harvest from a lake	

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Name	Applications	Remarks
Estuary models/ estuarial Dynamic model	- It simulates tides, currents, and discharges in shallow, vertically mixed estuaries excited by ocean tides, hydrologic influx, and wind action - Tides, currents in estuary are simulated	Dynamic model
Dynamic Water Quality model	- It simulates the mass transport of either conservative or non-conservative quality constituents utilising information derived from the hydrodynamic model Bay-Delta model is the programme generally used. - Up to 10 independent quality parameters of either conservative or non-conservative type plus the BOD-DO coupled relationship can be handled	Dynamic model
HEC-2	- To compute water surface profiles for steady, gradually : varying flow in both prismatic & non-prismatic channels	
SMS	- Lake circulation, salt water intrusion, surface water profile simulation model	Surface water Modelling system - Hydrodynamic model
RMA2	- To compute flow velocities and water surface elevations	Hydrodynamic analysis model
RMA4	- Solves advective-diffusion equations to model up to six non-interacting constituents	Constituent transport model
SED2D-WES	- Model simulates transport of sediment	Sediment transport model
HIVEL2D	- Model supports sub-critical and supercritical flow analysis	A 2-dimensional hydrodynamic model
MIKE-II, DHI	- Model supports simulation of flows, water quality, and sediment transport in estuaries, rivers, irrigation systems, channels & other water bodies	Professional Engineering software package

Annex V.3

Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Land Environment

Name	Applications	Remarks
Digital Analysis Techniques	Provides land use / land cover distribution	
Ranking analysis for soil suitability criteria Affected micro-flora /micro-fauna	Provides suitability criteria for developmental / conservation activities	Various parameters viz. Depth, texture, slope, erosion status, geomorphology, flooding hazards, GW potential, land use etc. are used

Annex V.4

Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Biological Environment

Name	Relevance		
Flora			**Remarks**
Sample plot methods	Density and relative density Density and relative dominance	Average number of individuals species per unit area Relative degree to which a species predominates a community by its shear numbers, size, bulk or bio-mass	The quadrant sampling technique is applicable in all types of plant communities and for the study of submerged, sessile (attached at the base) or sedentary plants
	Frequency and relative frequency importance value	Plant dispersion over an area or within a community	Commonly accepted plot sizes : 0.1 m2 - mosses, lichens & other mat like plants
		Average of relative density, relative dominance and relative frequency	1.0 m2 - herbaceous vegetation including grasses

			10-20m2 - for shrubs and saplings up to 3m tall, and
			100 m2 - for tree communities
Transects & line intercepts methods	Cover	Ratio of total amount of line intercepted by each species and total length of the line intercept given its cover	This methods allows for rapid assessment of vegetation transition zones, and requires minimum time or equipment to establish
	Relative dominance	It is the ratio of total individuals of a species and total individuals of all species	Two or more vegetation strata can be sampled simultaneously

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Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Biological Environment

Name	Relevance		
			Remarks
Flora			
Plot less sampling methods	Mean point plant Mean area per plant	Mean point-plant distance Mean area per plant	Vegetation measurements are determined from points rather than being determined in an area with boundaries
	Density and relative density		Method is used in grass-land and open shrub and tree communities
	Dominance and relative dominance		It allows more rapid and extensive sampling than the plot method
	Importance value		Point - quarter method is commonly used in woods and forests

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Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Biological Environment

Name	Relevance		
			Remarks
Fauna			
Species list methods	Animal species list	List of animal communities observed directly	Animal species lists present common and scientific names of the species involved so that the faunal resources of the area are catalogued
Direct Contact methods	Animal species list	List of animal communities observed directly	This method involves collection, study and release of animals
Countindices methods (Roadside and aerial count methods)	Drive counts Temporal counts	Observation of animals by driving them past trained observers	Count indices provide estimates of animal populations and are obtained from signs, calls or trailside counts or roadside counts
	Call counts	Count of all animals passing a fixed point during some stated interval of time	These estimates, through they do not provide absolute population numbers, provide an index of the various species in an area
			Such indices allow comparisons through the seasons or between sites or habitats
Removal methods	Population size	Number of species captured	Removal methods are used to obtain population estimates of small mammals, such as, rodents through baited snap traps
Markrecapture methods	Population size estimate (M)	Number of species originally marked (T), number of marked animals recaptured (t) and total number of animals captured during census (n) $N= nT/t$	It involves capturing a portion of the population and at some later date sampling the ratio of marked to total animals caught in the population

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Annex V.5

Guidance for Assessment Relevance and Reliability of Analytical Methods and Framework used for Impact Prediction: Socio-economic Environment

Relevance		
Name	**Application**	**Remarks**
Extrapolative Methods	A prediction is made that is consistent with past and present socio-economic data, e.g. a prediction based on the linear extrapolation of current trends	
Intuitive Forecasting (Delphi techniques)	Delphi technique is used to determine environmental priorities and also to make intuitive predictions through the process of achieving group consensus	Conjecture Brainstorming Heuristic programming Delphi consensus
Trend extrapolation and correlation	Predictions may be obtained by extrapolating present trends Not an accurate method of making socio-economic forecasts, because a time series cannot be interpreted or extrapolated very far into the future with out some knowledge of the underlying physical, biological, and social factors	Trends breakthrough precursor events correlation and regression
Metaphors and analogies	The experience gained elsewhere is used to predict the socio-economic impacts	Growth historical simulation common-sense forecasts
Scenarios	Scenarios are common-sense forecasts of data. Each scenario is logically constructed on model of a potential future for which the degrees of confidence as to progression and outcome remain undefined	Common-sense
Dynamic modelling (Input-output model)	Model predicts net economic gain to the society after considering all inputs required for conversion of raw materials along with cost of finished product	
Normative Methods	Desired socio-economic goals are specified and an attempt is made to project the social environment backward in time to the present to examine whether existing or planned resources and environmental programmes are adequate to meet the goals	Morphological analysis technology scanning contextual mapping - functional array - graphic models Mission networks and functional arrays decision trees & relevance trees matrix methods scenarios