INTERNATIONAL ROAD FEDERATION (IRF)
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MONITORING AND ASSESSING GREENHOUSE GAS EMISSIONS FROM ROAD CONSTRUCTION ACTIVITIES: THE IRF GHG CALCULATOR

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Abstract
Better roads can only be built by practitioners who are fully aware of the full ecological repercussions of their activities, and of the growing potential for enhancing positive while reducing negative impacts. The International Road Federation has designed a methodology for the calculation and modelling of greenhouse gas emissions (GHG) from road construction projects. The ultimate purpose of this tool is multifaceted: 1. Facilitating a detailed environmental analysis of road projects; 2. Providing an authoritative basis for comparative analysis of various road-building techniques and materials; 3. Optimising road construction site supply schemes with respect to raw material providers, choice of suppliers, delivery locations and material transport modes; 4. Enabling detailed estimation of GHG emissions that are specifically attributable to the road construction industry. The resulting calculations are given in CO2 equivalency by reference to all or any of the various stages of road infrastructure construction, and take into account a wide range of different scenarios and construction techniques.

Introduction

In today's demanding world, no industry can afford to ignore its impact on the environment and, in particular, on climate change. As we move into the future, better roads must be built by practitioners who are fully aware of the full ecological repercussions of their activities and of the growing potential for enhancing positive while reducing negative impacts. Already, modern road transport systems increasingly reflect the commitment of road builders, scientists and city planners in these respects – as well as their growing ingenuity in efforts to ensure and safeguard a better living environment. Sustainability has become a key watchword, not only in the design phase but also in the construction and implementation stages of road schemes. Factors such as potential for recycling materials as well as risks of water contamination, noise pollution and GHG emissions are comprehensively taken into account, and detailed consideration is given to appropriate measures to avoid or remedy any potentially negative impacts or issues that may arise.

Alongside other sectors, the road infrastructure industry is assuming the new challenges and responsibilities of our times. Committed to the green economy and to being at the forefront of global efforts to stimulate change for a sustainable future, the International

Road Federation (IRF) has designed a greenhouse gas calculator – CHANGER - specifically tailored to road infrastructure projects.

Objectives

The main objectives of the CHANGER project are to achieve tangible, long-term benefits for the global environment and to contribute proactively to the shaping of dynamic sustainable road development policies going forward.

Easy to use, and fully compatible with Intergovernmental Panel on Climate Change (IPCC) guidelines, the tool enables public and private entities to monitor and assess GHG emissions generated during the various stages of the road construction process.

The ultimate goal of this tool is multifaceted:

- Facilitating a detailed environmental analysis of road projects;
- Providing an authoritative basis for comparative analysis of various road-building techniques and materials;
- Optimising road construction site supply schemes with respect to raw material providers, choice of suppliers, delivery locations and material transport modes;
- Enabling detailed estimation of GHG emissions specifically attributable to the road construction industry.

Concept and Modelling approach

CHANGER adopts a comprehensive “input-output” modelling approach.

The calculation model is based on a simple set of equations that enable accurate estimation of overall GHG emissions (outputs) generated by each identified and quantified source (inputs).

CHANGER currently comprises two main modules (Figure 1):

- Pre-construction (clearing and piling, cut export and fill import transport)
- Pavement (on-site impacts, construction materials, materials transport, construction machines).

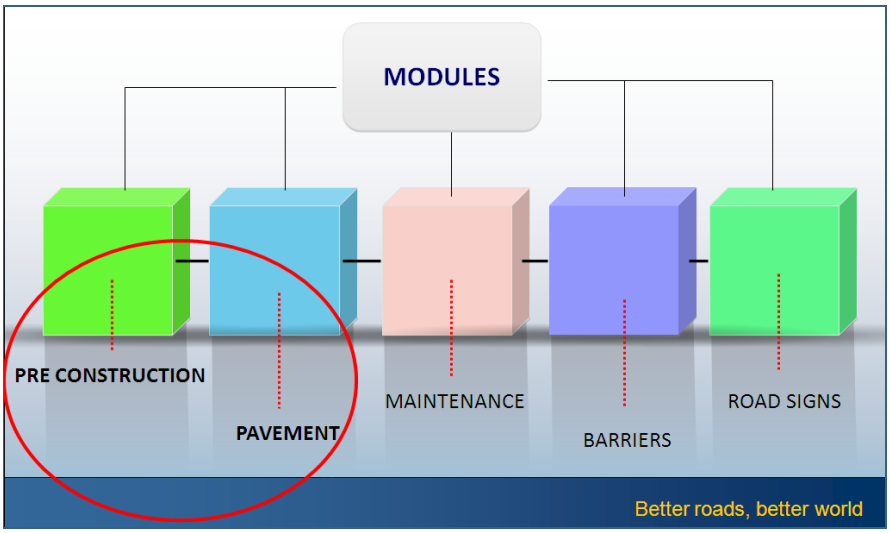

Figure 1

Every single module follows the same structure (Figure 2). Firstly, input data is entered by the user of the calculator. Then, a first calculation is carried out in order to obtain the material quantities, material transport, electricity used, etc. These quantities are finally assessed with emissions factors in order to output the total GHG emissions attributable to every stage of the road construction process.

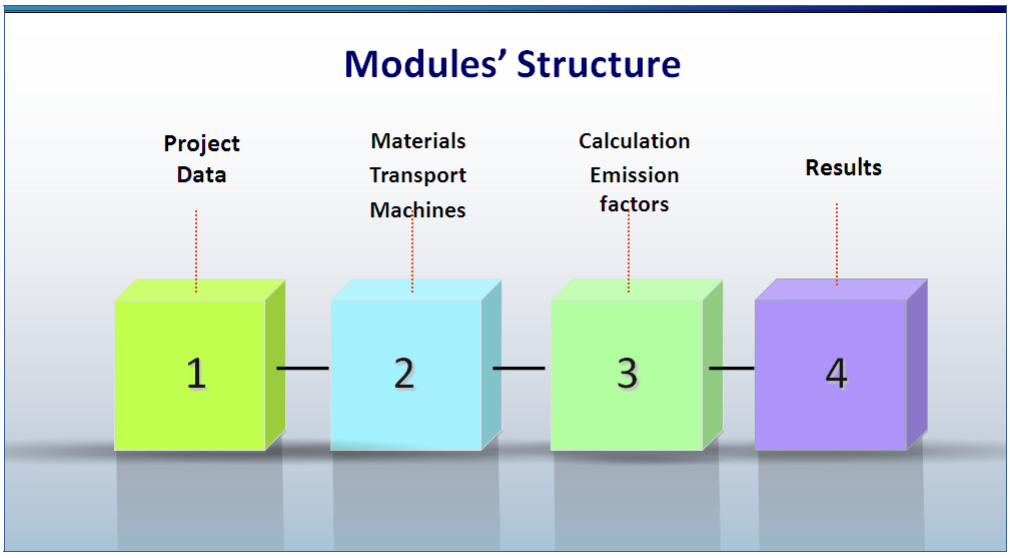

Figure 2

The research

The research has been organised in a series of successive and interlinked stages:

- Compilation of an exhaustive inventory of GHG emission sources by reference to the different stages of road infrastructure construction;
- Estimation of the level of intensity to be applied for evaluation of the emissions sources thus identified;
- Research and compilation of the applicable emissions factors, in accordance with guidelines provided by the Intergovernmental Panel on Climate Change (IPCC).
- Set up of the equation for the calculation: Emissions = Σ Source i *Emission Factor with Source: Si = (A*I)i, where sources are specified in units compatible with the emission coefficient; A = activity level and I = intensity.

Emissions sources

The calculator has been designed as a flexible tool that can accommodate a wide range of different user needs – from gross 'pre-project phase' estimations right through to comprehensive end-project assessment.

The pre-construction module takes into account:

- *Clearing and piling*: based on the ground surface area cleared per unit of road surface, an estimation can be generated for both machine use and fuel consumption. Transportation of trees removed is also taken into account (the tool does not account for either the loss of CO2 absorption by the removed trees or for their replacement with new or replanted trees in the areas concerned).
- *Cut exports and fill imports transport* to and from the road site: based on a simplified diagram, the user selects the relevant sites and enters the respective distances, tonnages and transport modes (road, rail or inland water).

The pavement module takes into account:

- *On-site impacts*: electricity and fuel consumption on the construction site as identified and evaluated.
- *Pavement construction materials*: this section encompasses several menus (unbound materials, hydraulically bound materials, bituminous bound materials, metals, rubber and plastic, etc.), from which the user can easily select the materials required for construction of the different layers of the given pavement.
- *Materials transport*: once again, a simplified diagram has been set up to help visualise and assess the emissions generated by transportation of the materials identified (Figure 3):

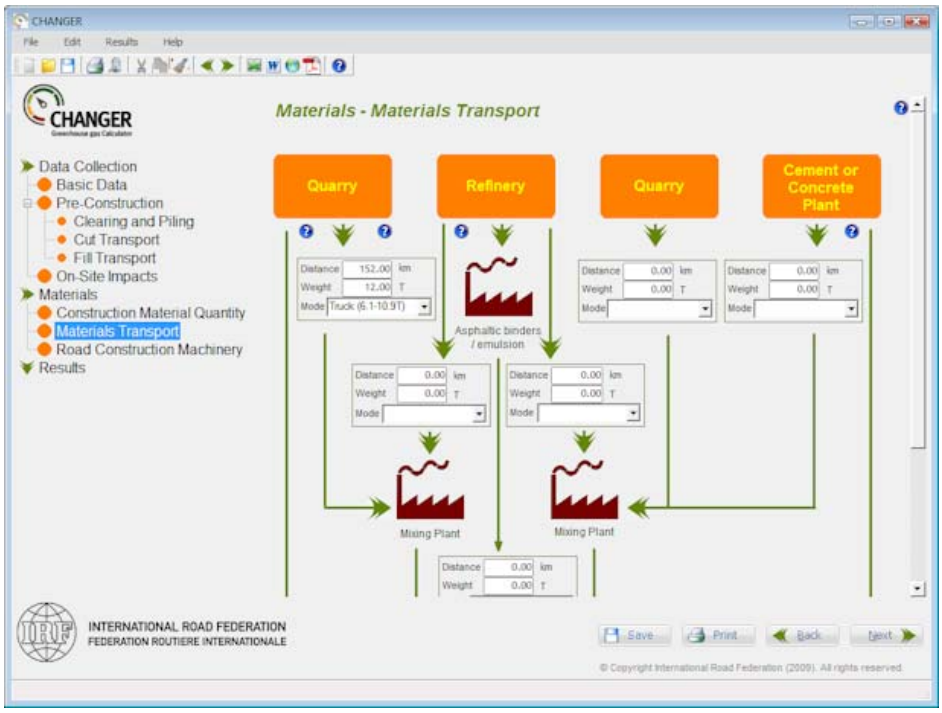

Figure 3

- For aggregates: two possible quarry sites are considered. Aggregates are transported either directly to the road site (granular materials for sub-base and filter drain) or first to the mixing plants (granular materials used for mixtures) and then to the road site;
- For bituminous materials: the system considers bitumen transport from the refinery to two possible mixing plant sites, and then from the plants to the road site. The model also accounts for the transport of emulsions directly from refinery to site;
- For cement: the system caters for both transport of cement directly to the site or via a mixing plant.
-For concrete: transport of concrete directly to the road site is similarly included as an option.

- *Construction machines*: The model estimates the number of working hours per type of machine and type of pavement layer. The total consumption of fuel is determined on the basis of the characteristics and efficiency of the material used.

Once assessed, the GHG emissions generated throughout the various stages of the road construction process are converted to carbon dioxide equivalent. Carbon dioxide equivalents are commonly expressed as "million metric tons of carbon dioxide equivalent ($MMTCO_2Eq$)".

CHANGER automatically generates comprehensive reports – either aggregated (total) or disaggregated (inherent to only one or more steps of the process) – that can be conveniently exported to Excel, Word and HTML (Figure 4).

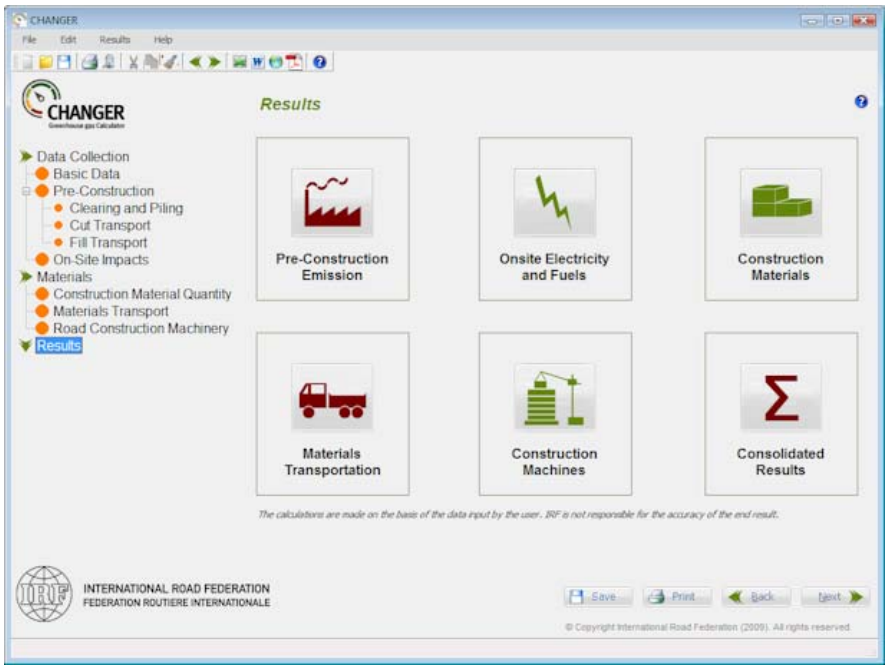

Figure 4

Validation process

By virtue of its extensive and varied membership – both in terms of geographical coverage and fields of specialisation – IRF has benefited from technical support from a wide range of industry and technical partners throughout the development of the project. This has been particularly invaluable for ongoing review and validation of the modelling approach and databases, as well as for testing and comparison.

The LAVOC (Traffic Facilities Laboratory) of the Swiss Federal Institute of Technology (Ecole Polytechnique Fédérale de Lausanne - EPFL) has analysed and validated both the quality and reliability of the databases and the calculation procedures.

Future developments (current state of progress, updates)

CHANGER has been conceived as an evolving tool, subject to ongoing review and development so that it ultimately covers every phase and aspect of road construction. Already, work is underway on complementing the existing pre-construction and pavement modules with a new module devoted to maintenance activities. Similarly, the databases will be regularly updated to reflect the very latest science as well as cutting-edge research on techniques, materials and equipment.

For more information on CHANGER are available on http://www.irfghg.org

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