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Climate Database Facilitating Climate Smart Meal Planning for the Public Sector in Sweden

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1 Introduction

1.1 Background

The climate impact of food consumption corresponds to about 2 tons of CO_2 eq. per capita, representing around 25 % of the total consumption-driven climate change impact in Sweden. There are several diverse ongoing trends of food consumption in Sweden, and their primary drivers are environmental and health considerations. The results of a market research carried out by YouGov (2010) indicated that nearly 75 percent of respondents would buy climate-labeled food, and nearly 50 percent of the respondents would be willing to pay a higher price for such a product.

The climate impact from meals could be significantly decreased through small changes in recipes by reducing the amount of ingredients with high carbon footprints or substituting them with other ingredients with the same function but lower carbon footprints. By making more climate-conscious choices, e.g. eating more vegetables as well as poultry, egg and seafood instead of red meat, the climate impact per person and year could be reduced by half.

Several recent studies suggest that dietary changes can reduce food-related environmental impacts significantly (e.g. Tilman and Clark, 2014; Hallström et al., 2015; Stehfest, 2014; Röös et al., 2015; Bryngelsson et al., 2016). These studies have mainly explored theoretical dietary scenarios, and not what people actually eat; for example, in one study a model-based theoretical diet, which reduced GHGs by 90%, included unrealistic amounts of only seven food items (Macdiarmid, 2012). Still, this information is important when aiming to guide food producers, public authorities and consumers towards more sustainable and healthy options. The national food agency Sweden updated their dietary advice in 2015, which now also takes environmental consideration into account, besides health impact (SLV, 2015).

To combat climate change, recommendations need to be realized and incorporated into applications in daily practices. There has been an optimistic belief that the availability of information could boost environmentally sound behavior among the general public, but there is a rather weak link between knowing and doing. Feedback directly tied to people's own behavior has been shown to be more effective than general information (Lundgren, 2000), for example by making the information available directly in the decision making moment e.g. when shopping food or planning a meal. If such information is timely communicated, it can have considerable contribution to more sustainable consumption. In a field experiment conducted by Matsdotter et al. (2014) in 17 food stores in Sweden, the results show that climate labeling increased demand for climate-labeled milk by 7%. In another recent research project (Kamb et al, 2015), households in Uppsala were able to reduce their climate footprint by 31% by having access to climate friendly information and inspiration, e.g. the participants could get direct feedback on GHGs for certain products and services via a mobile application. This project was conducted at a very small scale, but still proves the potential of influencing behavioral change by using interactive applications at the point of decision making.

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At the same time, the information supplied to the user needs to be scientifically robust. The European commission have acknowledged this, and developed a standard for how to calculate a product's environmental footprint (EC, 2013), which is currently being tested in a number of pilot studies across Europe. The aim of the commission is to develop a common approach to incorporate into existing or new EU policy; it might therefore in future become mandatory for producers to provide consumers with information on their products' environmental footprint.

However, today's food service providers, grocery shops and trading companies do not provide information, guidance or support for consumers to make a more climate friendly choice of meal,, mainly due to lack of access to scientific data for a major part of the food sold in stores and served in restaurants and commercial kitchens, along with a lack of means of communicating this data to the consumers.

This study presents an attempt to develop and communicate this knowledge through development of a climate database by SP Food and Bioscience (SP FB). In this database climate data and metadata are compiled and used as an additional service to existing nutrition information in the canteens' meal planning systems in the public sector. The work of this study is undertaken in the project titled "Climate data for conscious choice of food raw materials ", financed by the region of Västra Götaland.

The focus on the public sector is due to its great potential to bring about major environmental benefits to the community, both directly due to a large number of portions being served each day, as well as indirectly through an educational role for the consumers to increase the knowledge of the impact of food choices in the context of sustainable consumption. In Sweden, the public sector serves over 3 million meals per day. Each plate could contribute to a lower environmental impact through an active selection of raw materials – for example, a reduction of 200 grams of CO_2 eq./plate would be the equivalent of 600 tonnes of CO_2 eq. less per day. Therefore, the aggregated annual potential for climate improvements can be significant.

1.2 Aim and outline

The goal of the project is to implement a climate module within the existing meal planning tools used for public meals today. This requires a food and climate database developed by SP FB within the project. The ambition of the project partners who will use the tool after the project completion, is to to reduce the climate impact of food consumption in their public sector domain by over 20 % in three years, , through enabling the monitoring of climate impacts on a daily, weekly and annual basis with clear feedback on the resulting changes.

In the following section the method for collection of data as well as required adjustments to the climate data used in developing this database will be elaborated. It continues by presenting the resulting database and its applications. Following to that, there is a discussion addressing the potential of full exploitation of this tool in the public and private sector. Then, a number of limitations of this study are brought up. The final section presents the next steps necessary to be taken for full exploitation of the potential of tools of this kind with various applications and user groups,in contributing to achieve environmental targets.

2 Method

The structure of the database as well as the process of data collection and matching to the list of food articles are discussed in this section. Furthermore, approaches to bridge data gaps as well as required modifications to ensure proper data quality are addressed.

2.1 Database structure

The database intended to cover the full list of over 2000 food items, developed by the Swedish National Food Agency (NFA). The items presented are divided into 4 levels. Level 1 includes 13 categories of major food types, mirroring a listing made by the Swedish National Food Agency (NFA), including drink (not milk), fat and oil, fish and seafood, fruit and berries, vegetables edible roots and mushrooms, meat, food dishes and ingredients, dairy products, nuts seeds and pits, sugar/sugary foods, cereals/cereal products, eggs, and other foods. Level 2 and 3 are defined by SP. Level 2 covers 91 item groups (e.g. cheese, milk, yogurt, ice cream, cream, etc. addressing category of 'dairy products' in level 1).

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Level 3, extends the item categories up to 674 items. From a nutritional point of view (which is the purpose of the NFA database), there has been no reason to distinguish different product items based on production method or origin of the product. From a climate perspective, though, it is of interest to know how and where food is produced. In today's version of the database, different types of production methods and origin have been distinguished in levels 3; however, no distinction has been made regarding the producer or farm level.

Level 4 represents the NFA's detailed list of more than 2000 items. The NFA list is not static but changes over time as some items can be added, deleted or renamed. These changes are planned to be updated in this database accordingly.

In the developed database, there is a considerable difference between these categories in terms of the number of NFA items, the type of product and the level at which climate change has been investigated. However, specific climate data are to a large extent identified on level 3 category items, and not for the level 4 categories The reason for this is the limitation of available climate impact data which makes the identification on level 4 not feasible. In many occasions, however, the difference of impacts of articles on this level of detail is insignificant from a climate perspective and similar data could be matched to other items in a similar level 4 category directly or with some adjustments. These issues will be further discussed in the following section.

2.2 Development of the climate data base: data collection, modification and matching

In selecting climate data, on raw materials / ingredients for meals, the goal has been to find the climate data that best match the food item, and are of the best quality in terms of the how relevant the data are regarding geographical and time conditions. When it comes to climate change, large differences in climate impact in similar food items can exist depending on how the food production has been carried out and the geographical conditions. There are also metadata collected along with the climate data describing what the latter represents in terms of origin and production. Such information facilitates required modifications to make collected data fit for the purpose.

Information on climate data are taken from including the previous life-cycle assessments/carbon footprint calculations performed by SP as well as over 250 other national and international references e.g. scientific articles, publications from conferences, popular science reports, environmental / climate declarations, online sources including international climate labeling initiatives. This also incorporates simplified calculations and modifications based on SP's collective experience and network in the area of food and environmental impact.

The items considered as volume commodities for public meals have been identified in close collaboration with the project's participating organizations.

1 kg has been used in the project as the *functional unit*. Climate change, in all cases, is expressed in carbon dioxide equivalents/kg eatable food and thus includes the total climate impact of all GHGs (not just carbon dioxide). For example, meat and fish are recalculated as bone free product. If exceptions occur (e.g. egg with shell) they are clearly described in the product name.

As for the *system boundary*, climate impact is covered up to the raw material processing in industry. The transport from the industry, possibly through wholesale enterprises, to the organization that will cook the meal is not included. Exceptions are made for imported products where generally assumed transport impact is added to the current climate data. In some cases, international climate data is assumed to represent a Swedish production (when Swedish data are not available); here, production has been set as taking place in Sweden so that no transport impact has been added. Similarly, Swedish climate data formed the basis for some cases of Europe-based production, and in these cases the transport impact was included.

Cooking energy is excluded from some climate data, based on the knowledge that it is the production of raw materials, through farming or fishing, which accounts for the vast majority of a product's environmental impact. For cooked products such as roast meat / fish, steamed rice etc., they were recalculated through how much "non-

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cooked raw material" corresponds to 1 kg cooked product. The different methods of food preparation yield varying climate effects as boiling can lower the climate impact through water take up and thus a lower concentration of the food, while frying can yield a higher climate impact due to water loss.

Packaging of food commodities are not included in the climate data either. This choice of method has been made since this target group mostly uses large pack packaging when cooking a large number of meals. Most of the studies that the climate data are based on have considered consumer packaging, which gives a misleading high proportion of packaging per kg of food compared to large packs. There may be a few exceptions in the SP FB climate database where the package has not been excluded due to aggregated climate data.

For *organic food*, the selection of climate data is based on a thorough literature search of organic / conventional life cycle assessments of food. The Swedish government has shown considerable interest in promoting the use of organic products, hence there is a need to see how these choices in turn impact on the climate. Some methodological choices were made, after putting together the basis of knowledge compilation, to demonstrate whether a difference in climate impact between the conventional and the organic products can be determined or not. The underlying studies are based on comparative life cycle analyses, i.e. examining both conventional and organic food in the same way in the same study (thus with the same scope and conditions). The first step was to investigate if there were sufficient facts to say if there is a significant difference or not. When the difference in climate impact for a priority product exceeds 10 % between the two production systems, distinct data were used for organic and conventional production accordingly. Given the large uncertainties in food production, if the differences in climate impact between organic and conventional production are less than 10 %, organic is assumed to have the same carbon footprint as a conventional system.

To handle *data gaps*, simplified calculation methods tested and practiced in international research have been used to generate substitute data for similar types of products, thus ensuring that all key product areas are covered. As far as possible, Life Cycle Assessment (LCA) has been chosen as the basis for such calculations.

For some products, major gaps in the data has been identified, including refined "fruit and berry" like apple juice, venison, vegetable protein options (such as tofu, falafel, various types of beans and peas), exotic vegetables such as bamboo shoots, vegetable dairy alternatives, organic options, oriental spices and food ingredients, semi / composite products. However, this gap of data just had a minor impact on the final results of this project due to the fact that most of the above mentioned food items are not commonly used as ingredients in meals prepared in the public kitchens in Sweden.

In cases of data gaps, alternatives have been considered including seeking new projects or identifying new studies that can be used. If this search did not prove fruitful, various kinds of modifications/conversions have been made to existing life cycle analyses so that the climate data will better fit the purpose. Table 1 gives a summary of actions taken to manage the data gaps.

Table 1. Actions taken to manage data gaps.

Data gaps	Selected approaches to bridge data gaps
Lack of data in available studies	Substitute data for a similar product or simplified climate calculations based on the ingredients using climate data of the various ingredients in the SP climate database (including rupture / water absorption during cooking), secondary producers or data on food dishes from previous projects where SP calculated resulting climate change, and finally cooking recipes found on the internet.
Wrong geographic conditions	Data has been adopted as representative / used anyway. Climate data can be assumed to correspond to e g Swedish production even if it is based on foreign data.
Different functional unit used to calculate the climate	Conversion into the project's "right" functional unit (kg CO2 eq./kg).

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impact	
Different system boundary	Adjustments i.e. exclusion of the packaging carbon footprint, exclusion of cooking, etc.

Appropriate modifications are only possible in presence of adequate metadata. Relevant information on the climate data are selected as most representative for each level 3 item category - i.e. the extent and choice of method in the current data source, description of the modifications, calculations etc.- that have been made for calculation of the relevant climate data. This information describing climate data is here (and in the life cycle assessment community) called metadata. Table 2 presents examples of metadata documentation in the database.

Table 2. Examples of metadata documentation in the database.

Metadata on:	Documented as:
Production method Geographic region (country or origin, catch area for fish)	o Imported from Southern Europe, o Air Transported, o Cultivated open land, o Cultivated in greenhouses o Organic/conventional o Type (fried, whole or per edible portion of a fruit)
Calculation method	Climate impact of a recent item "X" is calculated in kg CO2 equivalents / kg by multiplying the climate data for item "X" with the current amount required as food ingredient for the planned meal then added together to give the whole climate impact for the meal.

3 Results

The database developed in this project has been incorporated into the Diet and Nutrition planning software systems (e.g. Matilda, Aivo and Mashie) used in planning meals at several public kitchens in Sweden. This provides the meal planners with the opportunity to compare alternative solutions for a climate-conscious meal with a smart choice of resource-efficient and nutritious ingredients. The developed climate database has already been incorporated,or is in progress of being incorporated in about 20 municipalities across the country - e.g. Västmanlands läns landsting, Region Skåne, Landstinget i Sörmland, Stockholms läns landsting, Västra Götalandsregionen, Göteborgs stad, Härryda kommun, Norrköpings kommun, Borås stad, Eskilstuna kommun, Umeå kommun, Huddinge kommun, etc. - to reduce the climate impact of the meals offered in the public kitchens in their territory. The improvement results achieved so far has already raised considerable attention, thus paving the way for rolling out implementation of this tool across Sweden.

As a part of this project, updates of the database on a regular basis is foreseen. A frequent update is to incorporate new studies providing a better picture of the current situation. The handling of the climate database is an iterative process where the data will be updated continuously. Accordingly, the climate figures for many foods will change as the production and consumption is constantly evolving, thus requiring new studies to be carried out to reflect the new reality. Changes may also be due to items entering or disappearing from the NFA database of neutral food items.

Depending on the degree of interest in the climate database, it may also be necessary to develop additional information, for example by developing new requested features. One aspect can be starting out by finding "hot spots", i.e. identifying meals that stand out from a climate perspective. For meals with a high climate impact, it can be considered whether it is possible to change their recipes by switching to other raw materials (if they are popular), serve them at less frequent intervals or maybe to consider excluding them from menus.

Conversely, it is of interest to find positive examples, such as popular meals with a lower carbon footprint. Making changes in the recipe by replacing portions of meat with vegetable protein can cause major climate benefits even if the change is not perceived as large by the consumer. From a climate perspective, replacing beef with pork or poultry in a mince sauce or a stew provides a high impact. The differences become especially clear when multiplying the climate benefit (saved amount CO_2 eq. /meal) with the number of portions served in a business.

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4 Conclusion and discussion

This study gives an overview on development of a climate database which is used to reduce the climate impact of meals served in the public sector in Sweden. This database is used by about 20 municipalities across Sweden to provide the public sector with information on their meal planning and how different ingredients and dishes affect the climate. Knowledge of raw materials' impact on the climate have long existed, but integrating such data in meal planning tool enables the food service sector to compare alternative ingredients while planning a meal not only based on nutrition and cost but also considering climate change.

The results provide the potential of reducing the climate impact of an average meal by about 20%. Given the total amount of ca. 3 million public meals served each day in Sweden, use of this integrated tool can help reducing the climate impact with more than 700 tonnes of CO2-eq per day. The tool is also of interest for companies and restaurants in the ready meal sector.

Besides its direct contribution in reducing climate impact, a good knowledge of the meal contribution to climate change provides better conditions for the decision makers at different levels to set the correct objectives and priorities in the improvement process. Important elements in success of all environmental work, is communication and cooperation with all stakeholders engaged i.e. teachers, meal consumers, health professionals, parents, politicians. For this purpose different communication mechanism are required in approaching different beneficiaries including individual consumers, decision makers and politicians as well as educators and coachers working with the subject.

Another important issue is the complementary aspect of sustainable food consumption and sustainable food production when it comes to managing demand and motivating climate conscious food products. Use of this tool will incentivize food producers supplying meal ingredients to the public kitchens to improve their production. As an example, SP FB has started a joint project with the meat processing industry to provide a documented plan to build up the producers skills on the climate impact of their production widely within the company, and to communicate such knowledge with external stakeholders including a dialogue with their meat suppliers to ensure that they work with continuous improvements in primary production. Other objectives are to replace part of the meat content with vegetable raw materials, reduce energy used in production, use of renewable energy sources as well as food waste prevention in their production processes. The latter, food waste prevention, is identified to be another major contributor to reducing climate impact of food not only in the production stage but also at the consumption level in canteens.

5 Limitations

The database in its current status is not open to be used by public and private sector even individuals in the society to monitor the climate impact of food consumption. For such a tool to be effective, it needs to be accessible in a large scale and the means for that needs to be provided by relevant authorities to facilitate open and large scale use of the tool in Sweden.

It is also important to mention that climate change is just one of the major environmental impacts caused by food production and consumption, although an important one. Therefore other tools are also required to ensure meeting all environmental objectives. Development of such tools needs to be done in parallel, i.e. use of certification or labelling mechanisms e.g. MSC-labeled seafood or IP-certified agricultural production.

6 Future work

There is a need to do more research on incorporating the health factor as well as other environmental impacts (e.g. land use, water use, eutrophication, ecotoxicity etc.) in this tool in a way that it reflects sustainability in its totality. The challenges remain though, to have sufficient data quality to ensure scientific robustness without making the assessments too costly.

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For the climate data generated to better resemble the reality, there is also a need to broaden the current system boundary used in generating climate data to include more life cycle phases like transports, cooking and packaging.

In the current version of integrated meal planning system, in choosing individual food items, customers of canteens are given the option of choosing either the "best in class" for a given product or a similar product (with the same function in e.g. a meal) with a lower carbon footprint. However, to better exploit advantages that such a tool offers, a simplified limited version customized for the use of individuals in society needs to be developed enabling them to track the environmental impact of food for their private consumption and thereby motivate more climate conscious choices while shopping and planning meals.

This also incentivizes food producers to improve their production, a measure with great potential to reduce the overall climate impact of food consumption. At the same time, it is also important to provide an opportunity for producers to communicate specific carbon footprints from their unique products/production in the database. In the current version of the database, no distinction has been made regarding the producer or farm level. If the need or desire arises to link specific climate data at the food supplier level, this could be made possible in the future, for example through a connection to Dabas. Dabas is the largest open database of food items' quality information for the food products available on the Swedish grocery market. Since Dabas is a producer-based database, such initiatives have to rely on a demand and interest from food producers themselves.

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