FDMT Customisation for its Use in the Czech Republic

F I N A L v e r s i o n

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FDMT Customisation for CR

RODOS(WG3)-TN(98)-14

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Management Summary

The report considers adequacy of the RODOS food chain and dose module for its use for the Czech Republic territory. The topic is analyzed from the point of view definition of radioecological regions and selection of a proper local group of plant and animal products. Possibility of determination of all local-dependant model parameters is discussed. The process of local data selection and acquisition is described with a special attention to construction of gridded environmental data and its further transport to European database.

Contents

Introduction

An adequacy of the RODOS food chain and dose modules has been analyzed in relation with specific conditions valid for the Czech Republic. Agroclimatic conditions, human consumption habits and animal feeding diets were investigated in order to determine if the complete local data is available. Differences were assessed between the local values and default FDMT values included in the current version of RODOS system. The FDMT of RODOS was found to be qualified to accept all specific features of FCM modeling in the territory of the Czech Republic.

An attempt was done to define radioecological regions for the Czech Republic on the basis of more profound analysis taking into account agricultural production process, agro-climatic conditions and phenological characteristics, human consumption habits considering both season and age dependent rates, feeding regimes for animals, etc. Insufficient existing data and lack of financial resources for external co-operation and manpower led to some simpler solution, when three radioecological regions were declared on the basis of altitude. The definition was confront with a set of agro-climatic maps [1] for several main plants. The maps are the only available overall relevant material and cover period 1931 - 1960. But we believe it comprise still high degree of relevant information. Comparing the maps with radioecological regions based on purely elevation basis, we can reveal strong correlation.

Collection of all necessary data for adaptation of the FDMT to local conditions is still ongoing process. So far no law regulations related to providing of information exists in the Czech Republic. Many institutions have restricted the range of collected data since 1990. If some data are available, its format is mutually incompatible (rivalry between civil and military sectors) and far from RODOS requirements. All this facts together with poor financial resources insufficient for data acquisition from commercial data providers made the data collection for RODOS customization very difficult and time consuming task. Available RODOS default data for Central European conditions together with the collected national data used within our Czech model ENCONAN for dynamic food chain modeling were used as a basis for determination of the local FDMT data.

Nevertheless, the positive effect of the investigation was establishing good collaboration relationship among several proper experts teams in the Czech Republic. Then, the basic set of data is gradually updated on the basis of expert analysis resulted from co-operation with the external partners.

Adequacy of the FDMT parameters for regions of Czech Republic was considered. As for definition of number of feedstuffs and foodstuffs products we have found the later changes made by developers to be useful for our territory. The smaller number of the standard products being considered in every region enables to increase the number of optional products specific in separate regions. As for maximum allowable number of feedstuffs in animals' diet the increase of the number to 8 is quite sufficient.

Collection of soil type data and its processing to proper format was done in correspondence with the later decision of RODOS developers. Soil type data are determined for each of the grid point. This means that soil type dependent soil-plant factors are determined individually for each grid point regardless on the kind of radioecological region. Then, soil type does not enter into definitions of the radioecological regions. Final result is detailed surface definition of soil type distinguished according to its texture on the grid 1 x 1 km for the whole Czech Republic.

Special attention has been devoted to the construction of gridded environmental data necessary for the radioecological regions and countermeasure calculations within RODOS. Data on population surface density according to particular age categories, agricultural production, numbers of animals, soil types and other items has been concentrated in a special intermediate gridded file. It consists of 82 138 records, each record stands for tile 1 x 1 km and comprises many items characterizing the various properties on the tile (co-ordinates of the tile, maximum altitude, identification of radioecological region, district number, average population according to age categories, surface and soil characteristics, agricultural data on the tile for all relevant products etc.).

A part of the file is demonstrated in supplement 1. The grid continuously covers the whole surface of the Czech Republic and after its final transformation to geographical coordinates it should be continuously linked to neighboring countries. The intermediate file serves partly for automatic generation of a new data items and its easy actualization, partly for the final transformation to the required

RODOS format and finally will facilitate the data transition to European database.

1 Adequacy of the RODOS FDMT module

1.1Present status of knowledge in the Czech Republic

An attempt to model radioecological transport has some tradition in the Czech Republic and then the judgment of adequacy of the sophisticated FDMT of RODOS can start from a certain level of knowledge. A special model ENCONAN (Environmental Contamination Analysis) has been developed [4] and basic local data were collected. The model was successfully verified by its author within VAMP validation study for CB scenario [5].

The model simulates all specific pathways and selected model parameters, reflects kinetics of deposition on the plant surface in the various phases of vegetation period, transport through leaves or roots to the plant and transport from feed to animal products. The success of modeling is also dependent on many additional factors including feeding conditions, farming practices and crop processing technology used in the Czech Republic territory to prepare foodstuffs and feeding mixtures. The model represents deterministic modeling based on the method of concentration factors with exception of pork contamination, where dynamic compartment model is used. Food consumption rates originated from official trade balance data and their categorization according to various age group was done on the basis of negotiations with experts.

The ENCONAN model was built-in into national code HAVAR used in CR for simplified assessment of accidental releases of radionuclides from nuclear facilities. The modification of the ENCONAN for purposes of assessment of radiological consequences of routine releases of radionuclides to the environment was introduced to national code NORMAL. Partial comparison of the dynamic ingestion model included into HAVAR product with the corresponding food chain model on COSYMA code has been performed with special attention to iodine transport. The results are presented in ref. [21].

From this follows that the obsolete static modeling of ingestion pathway was substituted by dynamic FCM and that there is a certain level of knowledge of the problem. Many of model parameters have been already investigated and real data collected [6]. All this means a good starting position for assessment of FDMT adequacy and its customization.

The following areas were already investigated in relation with application of ENCONAN model:

Plants considered:

- Leafy vegetables (spring)
- Leafy vegetables (autumn)
- Root vegetables
- Fruit vegetables
- Winter wheat
- Spring barley
- Potatoes
- Fruits
- Maize + maize bulbs
- Beets + beet leaves
- Grass - 1. harvest
- Grass - 2. harvest
- Grass - 3. harvest

Additional plants have been selected for RODOS FDMT customization according to their importance on human consumption. The selection was done on the basis of [8, 9] where the corresponding complete district-average production values are available.

Plant characteristics:

- Beginning of the plant growth
- Harvest time
- Delay for consumption
- Yield of the plant (leaves area) during the vegetation period [kg/m^2]
- Dry contents
- Yield of the plant at time of harvest

Supplement 3 describes some of the data recently collected for purposes of food chain calculations according to former model ENCONAN generally used in the Czech Republic.

Annual consumption rates for different age categories were found for the following main foodstuffs:

- Leafy vegetables (spring)
- Leafy vegetables (autumn)
- Root vegetables
- Fruit vegetables
- Cereals
- Potatoes
- Fruits
- Cow milk and milk products
- Eggs
- Beef
- Pork
- Poultry

Feeding diets of animals:

Number of feedstuffs and corresponding intake rates are defined for cows, bulls, heifers, pigs, and poultry based on expert studies and mainly on publication [7]. Further discrimination is introduced for summer and winter diet. ENCONAN data for feeding rates are given in the supplement 3.

As for time delays for processing, distribution and consumption of feedstuffs and foodstuffs,

the values were usually estimated for the model ENCONAN (suppl. 3) from partial publications or on the basis of negotiations with various experts. The update for RODOS FDMT is ongoing on the basis of ref. [7].

Besides the items mentioned above many useful nuclide dependent and nuclide independent parameters were collected, which can be used in further FDMT customization.

1.2 Conclusion related to adequacy of FDMT for the Czech Republic

On the basis of previous experience we can conclude that FDMT model represents a new sophisticated tool which could substitute the former simpler models. It complies with the structure of the food chain modeling considered for Czech Republic and affords more detailed modeling with potential higher precision provided that the model will be fed by reliable local input data. Adverse effect for FDMT users is fact that the necessary data items are extremely extensive and cover much broader range what results to time consuming and tough process of data collection.

As for construction of the complete set of input values and their actualization it seems to be never ending process. Last section of this report describes the data collection, where at least four sources should be taken into account in order to reach reasonable compromise, which could enable to start real calculations:

1. To start with existing data being collected recently for the former model ENCONAN
2. Mining of the other necessary local data from various external providers and its merging and reconstruction to proper format
3. For the values which are not available and cannot be reconstructed is necessary to take some temporary measure:
    - define it on the basis of cooperation with expert teams
    - using for some temporary period the default values (see [16] - Model Par. for Central European Cond. - Appendix E)
4. Exchange of data for similar conditions between RODOS teams from various countries

Collection and construction of FDMT data for Czech Republic are submitted to internal quality assurance procedure within the „Accreditation of the RODOS for its use in Czech Republic“ task. For all data its source and future maintenance should be clearly defined and the values have to comply with the parameters explicitly defined in the corresponding obligatory governmental regulations (mainly the new Atomic Law). The results are summarized in ref. [18]

2 Definition of radioecological regions for the Czech Republic

Concept of radioecological regions has been introduced in order to account for differences in climate, phenological characteristics, agricultural production and feeding regimes, ingestion habits etc. An attempt was done to define radioecological regions for Czech Republic on the basis of more profound analysis. Many successful relations with various institutes has been established that seem to be good partners for the future cooperation and expert judgments. Unfortunately, there does not exist regular and continuous investigation of the FCM problems and governmental coordination is very poor. Insufficient existing data and lack of manpower and financial resources for external cooperation led to decision to adapt in the first stage some simpler solution. Then, three radioecological regions were declared on the basis of altitudes. There are some prospects to continue in more profound analysis performed on the basis of cooperation with a special expert team (potential members were found), mainly on the basis of [3] where an attempt for the new regionalisation is introduced.

Comment: An important modification has been introduced in the FDMT structure for facilitating adaptation to different regions. The RODOS gridded environmental database will contain information on soil type for each grid point individually. For the Czech territory the information is already available for each tile 1x1 km (more detailed information on soil type data are in the next paragraph 4 on LCMT data for CR). Then, the soil type dependant parameters (such as soil-plant transfer factors) are calculated individually for each tile. As a consequence, the soil type parameter can be excluded from the definition of the number radioecological zones. This decreases the necessary number of radioecological zones and leads to substantial reduction of input data volume.

The simplified conception of radioecological zone definition based on pure elevation basis was discussed with partners from the Czech Hydrometeorological Institute (department of agrometeorology), the Czech Agricultural University and Research Institute for Plant Production. Definition of radioecological zones was done automatically on the basis of selection from the intermediate gridded file (see fig. 1) according to elevations. Corresponding picture fig.1 was created by plot of 82 138 points according to selection criteria:

h < 450 m above sea => region no. 1 (yellow color in fig. 1 - light gray in b&w)

450 ≤ h ≥ 700 m   => region no. 2 (cyan color in fig.1 - gray in b&w)

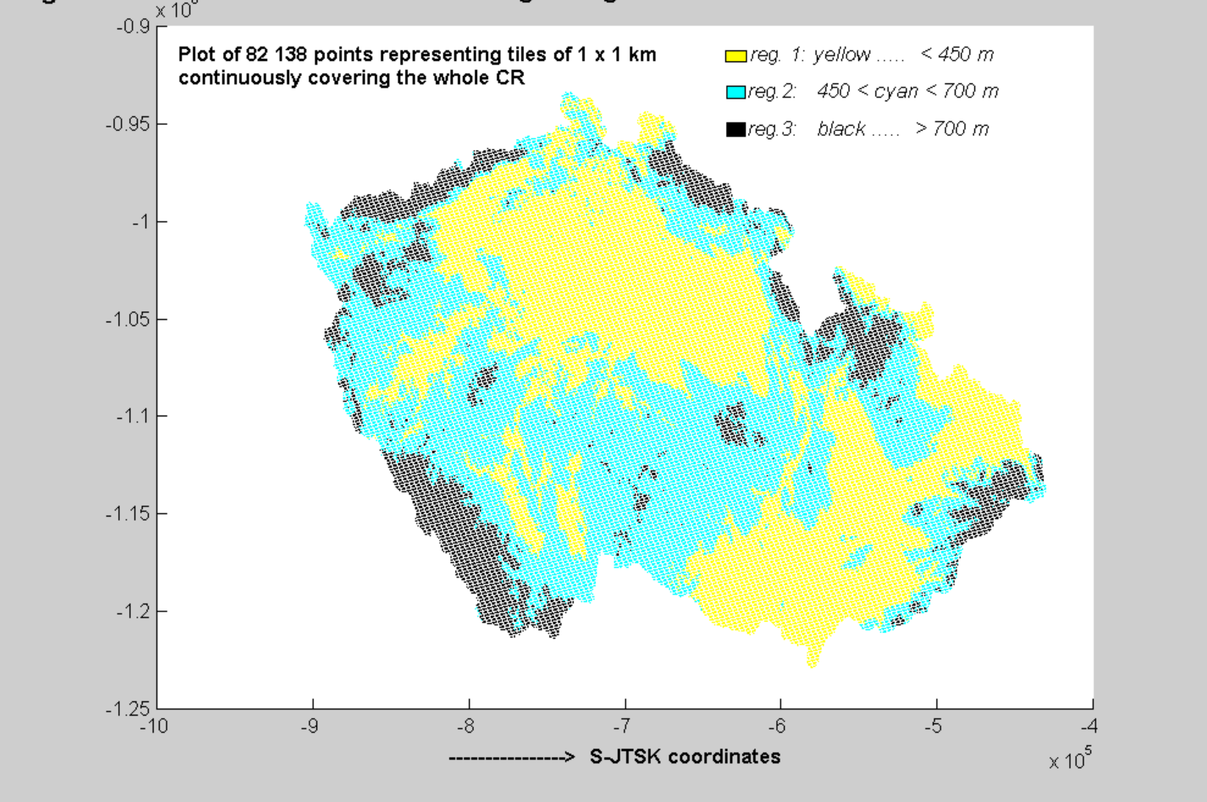
h ≥ 700 m above sea => region no. 3 (black color in fig.1 - black in b&w-nonagricultural)

The definition was confront with a set of agro-climatic maps [1] for several products and some facts from [2] and [3] bring good arguments for the compromise. For example on the fig. 2 is a map of beginning of harvest of winter-wheat for territory of Bohemia covering time period 1931 - 1960 , according to [1] (our digitalization of the map picture). Color scale covers date scale from July 5 (red), July 20 (yellow), August 5 (green) , ...to August 14 (dark green-blue). It represents surface mapping of the delay range of harvest beginning from July 5 to August 14. For purposes of comparison we have reduced the color range to 4 categories- see fig. 3. Then, when comparing the colored figure 1 with 3, we can declare a certain resemblance. Moreover, the same result can be find when comparing discrimination on 3 radioecological zones from figure 1 with another map no. 14 from [1] - Agroclimatological Zoning of CSR (1971). Here the discrimination according to average temperature on the territory was done. Three basic categories were introduced as:

- areas with high temperatures
- areas with mild temperatures
- areas with low temperatures

Also from there considerable resemblance with our 3 zone classification can be found.

Fig. 1: Definition of 3 radioecological regions on the basis of altitude



Additional important information related to selected radioecological zones are shown in tables 1, 2 and 3 , derived from the Statistical Yearbook of the Czech Republic 1997 [8] . The results are obtained from the measuring points being more or less regularly spread over CR. Table 1 gives measurements from 22 meteorological stations and the results stand for 1996 year. The similar values are given in table 2, but it represents long-term climatic means 1961 - 1990. Important values directly connected with the plant grow are given in table 3 where monthly and annual soil temperature means valid for 1996 year are presented.

Table 1: *Selected climatic data from various meteorological stations:*

year 1996

Meteorological station in CR	Radio-ecological zone	Altitude (m)	Year average air temper.(°C)	Precipitation (mm/y)	Sunshine (hours)
Doksany	1	158	7,5	465,7	1447,1
Velke	1	196	8,4	524,6	1750,9

Pavlovice					
Holesov	1	224	7,5	650,7	1623,4
Semcice	1	234	7,5	618,1	1485,2
Brno,Turany	1	241	7,7	537,4	1675,5
Mosnov	1	251	6,9	837,5	1390,3
Olomouc	1	259	7,4	598,3	1632,9
Praha, Karlov	1	261	8,1	509,5	1467,1
Hradec Kralove	1	278	7,8	628,3	1603,9
Kucharovice	1	334	7,1	573,9	1783,5
Praha, Ruzyne	1	364	6,5	513,4	1521,6
Ceske Budejovice	1	388	7,1	712,8	1518,9
Liberec	1	398	5,9	866,9	1405,7
Klatovy	1	430	6,8	675	1441,9
Velke Mezirici	2	452	6,4	692	1598
Tabor	2	461	6,3	616,8	1378,1
Cheb	2	471	6,1	526,8	1342,6
Pribyslav	2	530	5,8	583,8	1583,8
Svratouch	3	737	4,8	702,6	1600,2
Milesovka	3	833	3,8	615,2	1529
Churanov	3	1118	3,4	1110,1	1499,2
Lysa hora	3	1324	2,3	1475	1521,3

Fig. 2: Differences in harvest time of winter-wheat on the Czech territory time period 1931 - 1960 , according to [1], 10 colours covers date scale from July 5 (red), Jully 20 (yellow), August 5 (green) , ...to August 14 (dark gereen-blue)

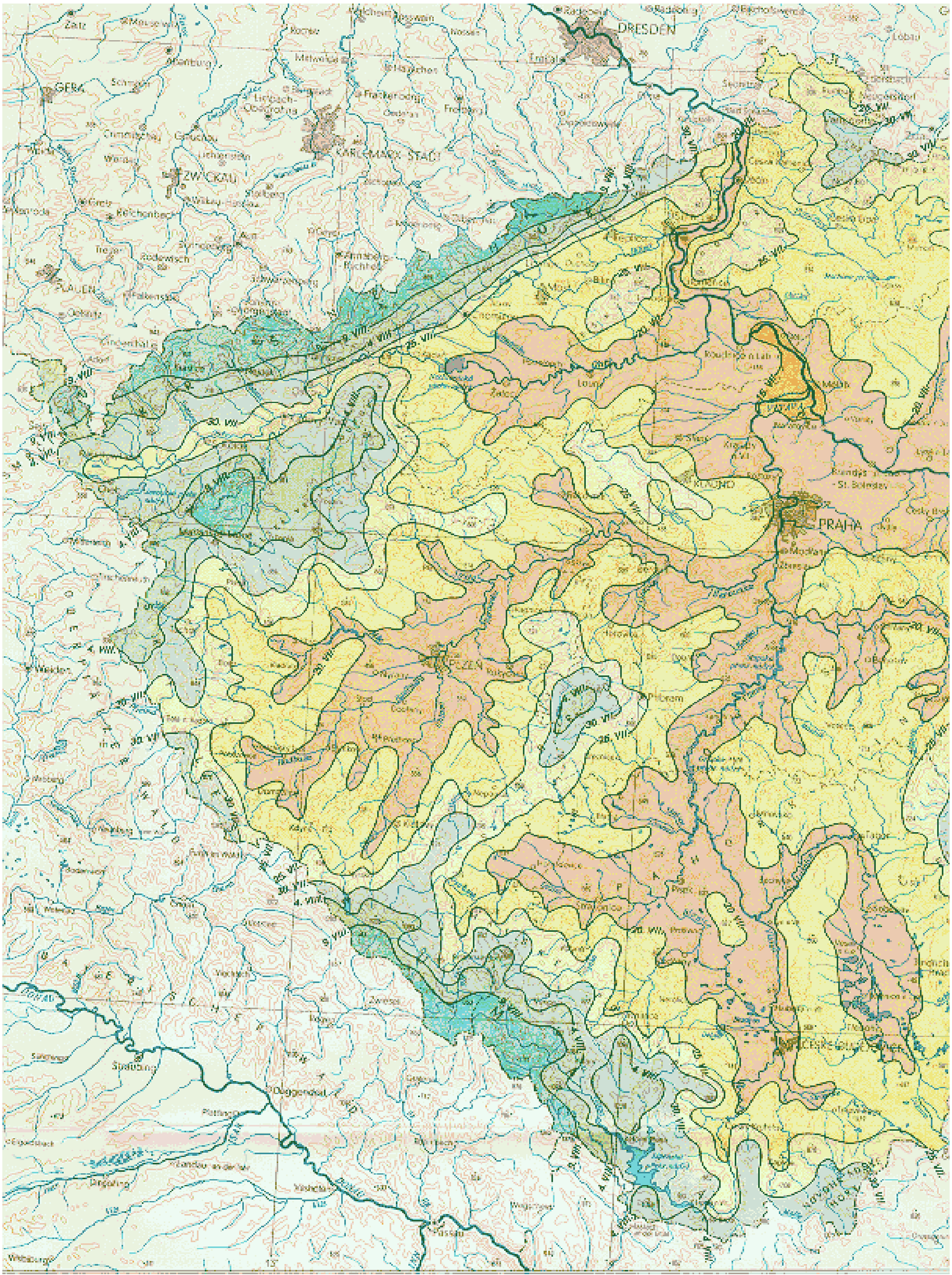


Fig. 3: Differences in harvest time of winter-wheat on the Czech territory, time period 1931 - 1960 , according to [1], reduction of fig. 2 to 4 colours covering July 5 (red), Jully 20 (yellow), August 5 (green) , ...to August 14 (dark gereen-blue)

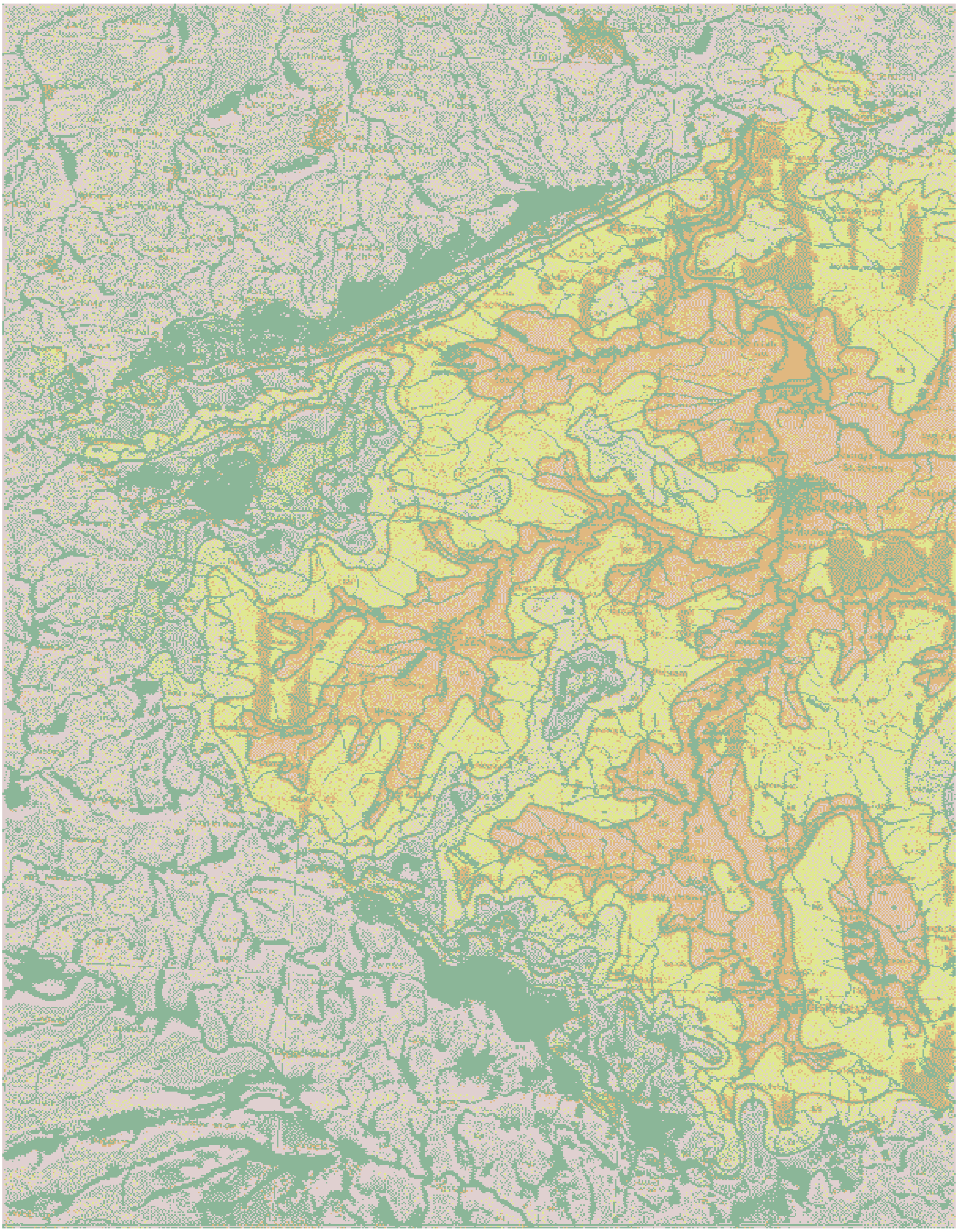


Table 2: *Selected climatic data from various meteorological stations:*

Long-term climatic means 1961 - 1990

Meteoro-logical station in CR	Radio-ecological zone	Altitude (m)	Year average air temper. (°C)	Precipitation (mm/y)	Sunshine (hours/y)
Doksany	1	158	8,5	455,9	1444,7
Velke Pavlovice	1	196	9,3	490	1776,2
Holesov	1	224	8,5	615,4	1660,1
Semcice	1	234	8,7	578,7	1573,6
Brno,Turany	1	241	8,7	490,1	1677,4
Mosnov	1	251	8,2	701,8	1566,5
Olomouc	1	259	8,7	570	1616,7
Praha, Karlov	1	261	9,4	446,6	1611
Hradec Kralove	1	278	8,5	616,8	1621,8
Kucharovice	1	334	8,5	470,5	1792,6
Praha, Ruzyne	1	364	7,9	525,9	1668,3
Ceske Budejovice	1	388	8,2	582,8	1564,3
Liberec	1	398	7,2	803,4	1388
Klatovy	1	430	8	599,8	1548,8
Velke Mezirici	2	452	7,2	594,4	1592,1
Tabor	2	461	7,6	578,8	1349,6
Cheb	2	471	7,2	560,1	1420,1
Pribyslav	2	530	6,6	675,3	1552,5
Svratouch	3	737	5,7	761,5	1548,9
Milesovka	3	833	5,2	544,9	1703,1
Churanov	3	1118	4,2	1090,7	1691,7
Lysa hora	3	1324	2,6	1390,8	1472,5

Table 3 : *Monthly and annual soil temperature means: 1996*

Temperatures in depths of soil: 5, 10, 20 cm

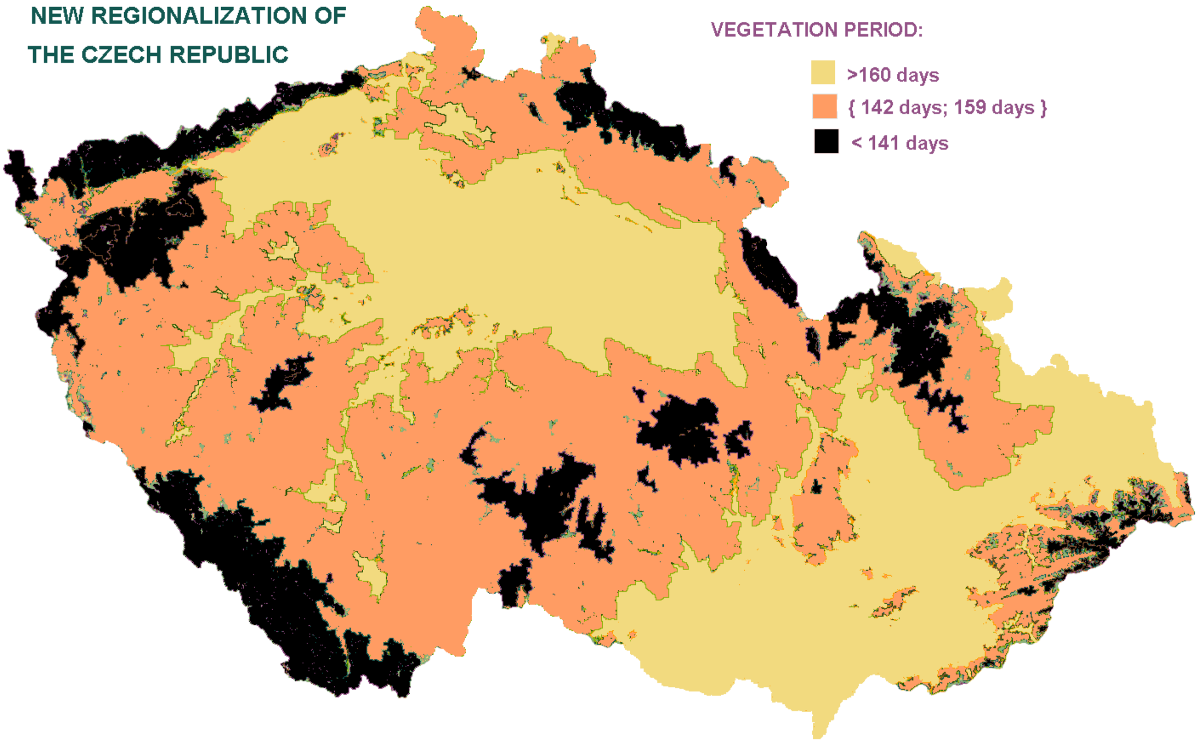
Measuring station (altitude)	**Depth** (cm)	**Mean monthly soil temperature (°C)**								
		1.	2.	3.	4.	5.	6.	7.	8.	9.
Doksany	5	-2,4	-2,5	1,4	10,5	15,8	21,2	20	20,4	12
(158 m)	10	-2,2	-2,4	1,2	10,3	15,6	21	19,9	20,6	12
	20	-1,7	-2,1	0,9	9,4	15	20,5	19,4	20,3	13
Pohorelice	5	-0,7	-1,9	1,2	9,2	17,5	21,8	21,2	20,5	14
(183 m)	10	-0,6	-1,8	1,1	9	17	21,4	21	20,3	14
	20	0	-1,4	0,9	7,9	16,4	20,6	20,7	19,9	14
Zatec	5	-1,2	-2,1	-0,3	7,8	14,5	19,1	19,1	19,4	13
(201 m)	10	-1	-2,1	-0,4	7,4	13,8	18,3	18	18,8	13
	20	-9,8	-2	-0,5	7	13,3	17,8	17,7	18,5	13
Slavonin	5	-1,3	-2,6	-0,5	7,6	16	18,9	17,7	17,8	13
(225 m)	10	-0,9	-2,2	-0,4	7	14,6	18,4	17,5	17,9	13
	20	-0,5	-1,9	-0,5	6,4	14,1	18,1	17,5	18	13
Kromeriz	5	-2,3	-3	0,4	9,6	16,3	21,1	20	20,3	12
(235 m)	10	-1,8	-2,6	0,3	9,5	16,2	20,9	20	20,3	12
	20	-1	-2	-0,1	8,8	15,3	19,8	19,2	19,7	13
Opava	5	-0,8	-2,4	-1,3	4,4	13,3	17,6	17,6	17,6	11
(272 m)	10	-1,5	-2,3	-1,3	3,8	13	17,3	17,4	17,5	12
	20	-0,8	-1,8	-1,1	3,6	12,7	17,1	17,1	17,4	12
Liberec	5	-1,1	-1,8	-0,7	4,7	11,6	16,2	16,9	18	12
(398 m)	10	-0,4	-1,4	-0,5	4,2	11,1	15,5	16,2	17,5	12
	20	0,2	-1	-0,2	3,7	10,7	15,1	15,7	17	12
Havlickuv Brod	5	-0,9	-1,4	-0,5	7,4	13,9	18,2	17,5	17,8	12
(455 m)	10	-0,6	-1,2	-0,3	7,2	13,8	18,2	17,6	18	12
	20	0	-0,9	-0,2	6,4	13,4	17,1	17	17,5	12
Vyssi Brod	5	-1,6	-4,7	-2,9	4,8	12,5	18,6	17	16,8	11
(595 m)	10	-1,3	-4	-2,8	4,6	12,5	17,8	16,7	16,8	12

	20	0,2	-2	-0,9	4,3	11,7	16,5	15,8	16	12,3

Activities in RODOS customization should reflect significant findings of the Czech technical and scientific society. The new facts should lead to changes in so far accepted strategy. Such an example should serve the latest publication [3], where the new multi-parametric concept for regionalisation of Czech Republic is described. Relief of terrain, pedological characteristics, hydrology and climatic data of regions are investigated together. Such input are used thirty year (1961 - 1990) time series of measured temperatures and precipitation which are correlated with relative and absolute alimetric data. Distribution of thermal energy and humidity is considered as a main feature for discrimination. The new regionalisation for the whole Czech Republic from [3] could replace our present single - parametric definition of the radioecological regions based on elevation basis.

The new results from [3] are described in the conclusion paragraph of this report on fig. 7 where six categories are distinguished. Here we have done the further reduction of the map to 3 basic categories according to the global variable of time period, when grow conditions for vegetation are favorable (temperatures above 10^{o}C, the term “vegetation period” is used on figure 2). Thus we can define the new discrimination of the Czech Republic on radioecological regions (displayed on fig. 4) which represents more realistic approach. Anyway, it can be noticed strong resemblance between figures 1 and 4.

Fig. 4 : *Alternative improved definition of the radioecological zones for the Czech Republic based on the new methodology from [3]*



3 Data collection for purposes of FDMT customization for the Czech Republic

3.1Data collection for each individual region:

Regional statistics were collected in the Czech Republic until 1991. Since this time there are available only some nonsystematic data from individual measuring fields. The structure of the agricultural production has changed substantially and deep changes in all fields are expected. Unfortunately, the process of restructuralisation is not so far well defined what results in deep recession of the branch. The main adverse features influencing agricultural production are:

- unclear owners relations
- high prices of chemical fertilizers
- lack of natural fertilizers and decreasing fertility of soil
- decreasing of sowing areas

- dramatic decrease of the numbers of animals

Then, the differences between radioecological regions are defined either on basis of old time series or some new nonsystematic particular measurements on trial fields and expert judgements. In all cases, the process of the data collection is continuous ongoing procedure and emphasis on the data maintenance should be done when all expected changes have to be reflected.

Such a basic material for the local parameters definition was accepted the RODOS report [16] on FCM model parameters. RODOS default values are more or less appropriate for mid Europe. The values were checked against known local values and will be substituted in the case of remarkable differences. The default values were used when no reliable source of the local data has been found. Slight local-specific modifications have been done in the structure of the plant species, foodstuffs, feeding diet and consumption rates. The experience from the former local FCM model ENCONAN was applied (see suppl. 3). A certain collected local data were sent to the extended appendix E (Model Parameters for Central European Conditions) of the joint report [22] .

Differences between radioecological zones arise mainly due to climatic conditions. The main effect is shift in vegetation periods of 14 to 20 days between zone 1 and 2. The third zone covers highland and mountain areas with rather low agricultural production. The change in plant production is adjusted implicitly for each tile (e. g. zone number) according to correlation of the district average value with other items valid for the tile 1 x 1 km. Otherwise, the structure of the plant cultivation, feedstuffs and foodstuffs production and processing and consumption habits are assumed to be similar in all regions.

3.2Definition of products

Official data related to crop and consumption were extracted from [9, 10, 17], feeding diets of animals were checked with [7]. The selection of the number of plants, animal products, foodstuffs and foodstuffs were selected on the basis of relative importance of the particular items in the references [7, 9, 10, 17].

Plants:

plant	*sowing areas (ha)*
Winter wheat	773909
Spring wheat	60228
Winter barley	158118
Spring barley	495333
Triticale	15068
Rye	75740
Oats	77823
Early potatoes	18604
Late potatoes	48316
Maize corn	34985
Maize green	269213
Beet	104515
Beet leaves	
Rape	299769
Leafy veg. spr.	4290
Leafy veg. aut.	~ 7000
Root vegetables	~ 14200
Fruit vegetables	~ 55000
Fruits	
Berries	
Mushrooms	
Alfalfa + clover	231400
Grass - I	195700
Grass - E	
Hay -I	
Hay -E	

Leafy veg. spr.:	lettuce, spinach, kohlrabi, radish
Leafy veg. aut.:	cabbage, cabbage (savoy), cauliflower
Root vegetables :	carrot, parsley, celery, onion, garlic
Fruit vegetables :	tomato, been, peas, cucumber
Fruits :	apple, pear, apricot, peach, cherry, sour cherry,

	strawberry, plum
Berries :	raspberry, currant, grape

District-average values for all plants are taken from [10]. A part of the original file is described in supplement 2. The file is merged to the intermediate gridded file, when the averaged values are correlated with other tile entities and recalculated to the gridded data (more detailed description is in [18] where quality assurance procedures for local data are described).

Animal products:

When deducing the importance of particular animals products on the basis of data from [17] the following animal products have to be selected for CR:

cow's milk

beef (cow)

beef (bull)

pork

veal

chicken

eggs

rabbit

Note: fish meat from local production is negligible (one time consumption during Christmas)

Feedstuffs:

On the basis of [7] and ENCONAN input data ([4, 5, 6] and suppl. 3) the following feedstuffs (and the corresponding feeding rates) were selected:

cereals + straw

grass

hay

grass E

hay E

silage maize

maize bulbs

potatoes

beet

beet leaves

skim milk

dry milk

whey

Foodstuffs:

Using reference [17] the following foodstuffs are selected (gross annual consumption rates for 1996 are also presented):

	1996 consumption (kg/y/person)
beef	85.3
veal	0.3
pork	49.2
poultry	13.6
rabbit	3,4
fresh milk	187.8
condensed milk	3.7
cheese (rennit)	1.8
cheese (acid)	4.7
butter	4.2
wheat flour	113.8
rye flour	87.0
oats bran	2.0
potatoes	77.2
eggs	13.8
Leafy veg. spr.:	4.0
Leafy veg. aut.:	19.2
Root vegetables :	25.4

Fruit vegetables :	30.5
Fruits :	32.3
Berries :	6.9
mushrooms	1.4
beer	157.3 l
drinks non-alco.	127.0

3.3Nuclide independent FCM parameters (region dependent)

Data related to yield of products, LAI values, characteristics of vegetation periods, soil properties, weathering rates, growth dilution rates and irrigation parameters should be defined for each radioecological zone and the data have to be restructuralised every time when the definition of the radioecological zones is improved. This seemed to be the most difficult task and as was mentioned above several possibilities of the data acquisition have to be taken into account, including ENCONAN data being collected recently, continuous mining of the further and more precise data from various external providers, using for some temporary period the RODOS default values (see [16]), exchange of data for similar conditions between RODOS teams from various countries and , mainly, definition on the basis of cooperation with Czech expert teams.

Some results of investigation are summarized bellow. The facts were found on the basis of cooperation with expert teams from the following Czech institutions:

- State Health Institute - see expert analysis [19]
- Czech Agricultural University (climatology, phenology)
- Research Institute for Soil and Water Conservation , Prague-Zbraslav
- Department of Cartographic and Geoinformatic, Faculty of Natural Sciences, Charles University , Prague
- Czech Institute for Hydrometeorology (dept. of agroclimatology)
- Ministry of Agricultural, Ministry of Living Environment

- RICP : Research Institute of Crop Production, Prague - Ruzyne (depts of Agroecology, Plant Nutrition, Plant Medicine, Genetics and Plant Breeding, Genebank)

In Q2/99 further expertise of collected local data was done, when default values of FDMT for Central Europe were compared. Corresponding expert judgement was done by institutes:

- RICP
- Potatoes Research Institute – Havlickuv Brod
- Agricultural Research Institute – Kromeriz
- Research Institute for Fodder Crops – Troubsko, near Brno
- Research Institute of Animal Production – Praha – Uhrineves
- Research Institute for Animal Nutrition – Pohorelice, near Brno

The judgement has been done on the “friendship” basis and responses were sometimes rather brief and formal. Nevertheless, a certain interesting results have been brought. But overall solution should be done in future on the commercial basis, when former time series (until 1991) should be processed and the results have to be correlated with the rapidly changing conditions mentioned above.

Two possible ways exists how to generate the region dependent data:

- experimental measurements
- mathematical modeling

Experimental way should be realised in a certain number of representative stations and represents expensive and long-term activity. Mathematical modeling closely connected to experiments means great advance in the fields. The methods are used in the Research Institute of Crop Production and theirs experts have offered to RODOS project further cooperation in future.

------------------- *note - begin* -------------------

Note on mathematical modeling of plant growth and yield used in the institute RICP :

In the past two decades many models of plant growth and plant yield have been developed. They differ greatly in their aim, complexity and universality. In plant production, both, models describing crops development at the scale of one specific field and models at the scale of region were used. The first are generally more exact and detailed in terms of soil, plant and climatic conditions parameters. The latter are applicable for wide variety of crops and they do not need detailed input parameters, especially as for soil, that are often not available.

In the RICP they tested several models such CANDY, AFRC, MODWht2, CERES, WOFOST, SUCROS, LINTUL or LEACHM. The availability of reliable input soil, plant and weather parameters is crucial for validation (and calibration) of a model to obtain reliable output results. There is the great amount of experimental data from various soil and climatic conditions from the past and running field experiments in RICP (some of) that could be used for the aim.

As an example some data produced in RICP with WOFOST model for Prague-Ruzyne are shown. WOFOST (World Food Studies) was developed in the Netherlands, some parts of it were derived from older models (e.g. SUCROS – Simple and Universal Crop Growth Simulators). It is part of CGMS (Crop Growth Monitoring System) , used in the frame of GIS (grid covering the whole EU) for prediction of crop yields. similarly to others, the model should be taken as a great simplification of reality.

In the following fig. 5 some results of simulations for LAI development are shown.

Fig. 5: *The simulated development of LAI in Prague-Ruzyne in 1973 and 1978.*

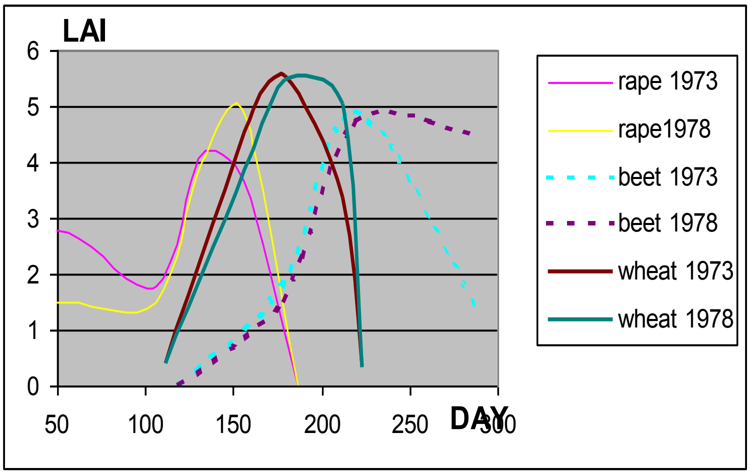


Table 4: *Average data, variability and range of observed and simulated crop and meteorological parameters in Prague (1961-1993, field data every other year from 1965 to 1993)*

meteorological parameters:

	Avrg. temperature	sun days	rain mm	rain	Avrg. temperature	radiation	rain mm
	months I -XII			XI-III (=cca winter supply)	IV-VII (main period - cereals)		
average	7,9	4,6	487	137	13,5	15,6	251
coefficient of variabil.	8,2	9,7	19	23	6,8	7,7	22,7
minimum	9,1	5,5	678	202	11,1	13,5	149
maximum	6,6	3,6	328	81	15,2	18,1	380

The interannual variability of weather conditions suggests effect on the extent of variability of growth and phenology, i.e. development of LAI, shift in phenology, stress factors decreasing maximum LAI etc. Thanks to a tight relation between sum of effective degrees and crop development the variability should be simulated well. However, specific soil, (micro)climate, agrotechnics, cultivar etc. conditions would change the real dates in a given field.

Table 4: *continuation*

product : spring wheat:

	observed day from sowing to harvest	simulated sowing to maturity	simulated sowing to flowering (max LAI)	Simulated Max LAI	
		fixed sowing day		irrigated	rain fed
average	141	136	87	5,5	4,9
coefficient of variability	141	137	87	10,6	17,6
minimum	129	123	97	4,0	2,7
maximum	153	146	87	6,4	6,0

Observed day of sowing, harvest and days from sowing to harvest in experiments, trials, should be taken as the lowest possible, because unlike farms, the experimental fields are harvest as soon as possible, lighter machinery is used-allowing to go even to wet fields, experimental fields are in better physical state, etc. The simulated variability, range, of maturity day must be by at least 14 days greater, as the day of sowing ranges up to one month in farm praxis.

Table 4: *continuation*

simulations for several plants:

simulations	sugar beet (fixed sowing)		winter rape (fixed sowing)				
	Simulated Max LAI		Simulated Max LAI		days from sowing to flowering	sowing to maturity	Julian day of maurity
	irrigated	rain fed	irrigated	rain fed			
average	5,2	4,1	5,4	4,0	134,8	281	187
coeff. of variability	5,5	27	26,4	44,3			
minimum	4,5	1,2	2,5	1,3	123	272	178
maximum	5,8	5,4	8,7	6,9	153	301	207

------------------- *end of note on simulation models* ---------

3.3.1 LAI - leaf area index of plants

Data on LAI are usually obtained by measuring (green) leaves area. However, there is also a relatively high area of green organs (up to 1-4) not accounted for in some crops. E.g.: Stems, ears, buds, in cereals, grasses, winter rape., cones in hops etc.

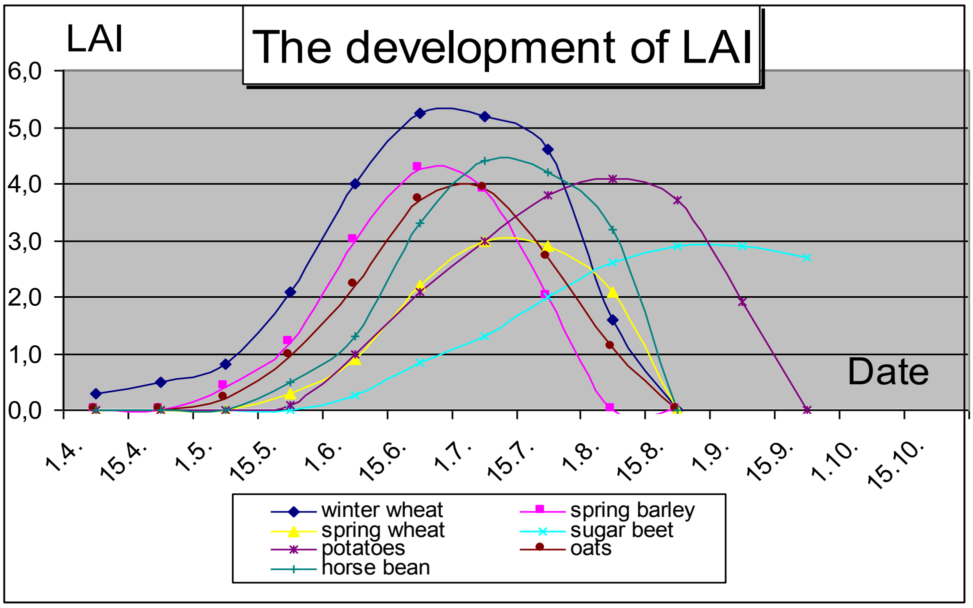
There are great differences in the development and duration during the year (Leaf area duration-LAD), and in maximal values among different years and sites. These are mediated by site and weather condition. It is difficult to separate the effect of altitude and soil fertility. Cereals are not too sensitive to altitude. On an average decrease in LAI could be anticipated over 400-500 m in cereals, except for oats, rye and winter rape, above 350 m in maize for grain and sunflower. Generally, soils in lower altitudes tend to be deeper and more fertile than in highlands. However, the warmer regions suffer from drought episodes during spring and summer.

The inter-annual differences in LAI may be roughly estimated from differences in yields of harvested products. It pays especially for the decrease due to droughts. A good correlation between LAI and yields are in grasses and other fodder crops.

The development of LAI is tightly related with the growth of plants in the stage of fast (linear) growth and there is a strong dependence on temperature. From it comes that the differences in the rate of LAI increase between individual years could be described by the progress of (accumulation) sum of effective degrees.

Figure 6: *Experimental results of LAI development in Prague-Ruzyne (average values)*

(radioecological zone 1: altitude = 364 m)



It should be mentioned that the physiological activity of leaves differs according to species, position and the age of leaves. Older leaves are less active in uptake (of nutrients). In plant production nutrients, especially N, Mg, P, micronutrients and hormones are applied to canopy in relatively small amounts (in comparison with total uptake from soil). Methods to trace the fate of leaf-applied compounds include the use of radioisotopes, as well.

3.3.2 LAITIME - Time grid for LAI data

From the shape of LAI development along the year it comes that intervals should be not regular in Julian day but rather in regular sum of degrees steps. That would better describe the period of fast (exponential and linear) growth, maximum levels attained and the start of decrease.

3.3.3 LAIMAXG - Maximum leaf area index of plant

The LAI in farm fields are estimated to be in lower part of the range for favorite condition and a higher range of less favorite condition.

Table 7: *The range of realistic maximum values of LAI observed in field conditions for the various crops*

	winter wheat	spring barley	oats	spring wheat	potat oes	sugar beet	maize (for green fodder)
intensive production, warm regions, plenty of water, fertile deep soils, optimal nutrition, stand without gaps, no extreme stresses	4-7	4-5	4-5	3-5	3-5	4-6	5-8
less favorable conditions but without extreme stresses, higher altitudes, drought, shallower soil temporary flooding, lower sum of effective degrees, lower radiation	2-3	2	2-3	2	1-2	3	2-3

Table 7: *continuation*

	horse bean	winter rape	sunflower	clover	alfalfa
intensive production, warm	4-6	3-4	4	4-6	4-8 (10)

regions, plenty of water, fertile deep soils, optimal nutrition, stand without gaps, no extreme stresses					
less favorable conditions, but without extreme stresses, higher altitudes, drought, shallower soil, temporary flooding, lower sum of effective degrees, lower radiation	2	1-2	2	2	2-3

The factors affecting the LAIMAXG could be compensated to some extent in a field. For example even in a cold regions high LAI values could be attained on a fertile soil with ample of water, especially in cereals, maize and in a warm year. Shortage of water more common in warm regions, on the other side, decreases growth and LAI. With high input of fertilizers and other agrochemicals, and irrigation high (yields and) LAI could be reached even in sandy, shallow soils, in warm regions.

Maximum attainable values of LAI could be by 2-5 greater than given in the table in overfertilised (especially with nitrogen), irrigated and too dense stands. However, average levels of LAI are optimal in the terms of yield formation, water consumption. Nowadays, farmers try to keep doses of nutrients and seeding rates as low as possible to increase the net profit. It suggests that LAI in farm fields are, generally, rather on a average and lower levels.

Table 8 : *Examples of maximal LAI in a farm fields and trials in 1997*

	w.wheat	**rye**	**winter triticale**	**w.barle y**	**spring barley**	**spring tritical**	**oats**
Zdarske hills (potato growing region), measured on 4.6., (winter cereals, 17.6. spring cereals), farm fields, RODOS radeco zone 2	1,9 – 2,7	2 – 5	2,9 – 4,6	2,4 – 3,3	3 – 5,4	1,4– 3,3	1,8 – 6,0
	winter wheat (0 kg N /ha – 100 kg N/ha)			**spring wheat** – 2 cultivars			
	1.6.	5.6.	10.6.	16.6.	11.6.	22.6.	
Prague-Ruyzne (beet growing region), trials,	2.1-3.5	2-3.2	1.6-2.1	1.1-1.6	2.6-3.2	2.5-2.9	

RODOS radeco zone 1							

LAI parameters for the first radioecological region (lowest altitude) are constructed also using data obtained from our Slovak RODOS colleagues [20].

3.3.4 YIELD - yield of plants at time of harvest

It could be possible to obtain real yield data from some farms. They need to have relatively exact data to calculate costs and profits. There are some enterprises cooperating for a long time with agriculture research and they should have reliable data on yields, sowing and harvest dates, feeding rates and other. Unfortunately, during collection of the yield data for purposes of the RODOS customization it was found, that only some fraction of the private data from some farms could be available. Then, the official yield data from [10] were used (the format of the raw data are shown here in the supplement 2) . The data represents district average production data for 77 districts of CR and for the all products selected for FDMT RODOS calculations and mentioned above. Its reconstruction on fine grid 1 x 1 km is described in the separate RODOS report [18] in the chapter related to quality assurance of local data.

It should be mentioned that data on yields are usually given not in dry matter unlike data in scientific papers or parameters in models. Thus, grain cereals yields are supposed to have 85 % of dry matter, beets have 22-24 % of d.m.

Inter annual variability could reach as much as 100 %. This year 1998 may serve as an example, with extreme decrease of cereals, winter rape, fodder and other crops due to drought in some parts of Bohemia unlike Moravia and highlands.

3.3.5 TGROWTH - beginning of growth of plants

During ENCONAN food chain model application for CR [4, 6] the local data sufficient for the simplified modeling were collected. Some of the values shown in supplement 3 can be used such a basis for collection of local data for the profound FDMT modeling.

Latest data can be found from research activities hold in RICP. From their investigations the beginning of growth may be estimated from the day of sowing and known average period to sprouting related to the sum of effective degrees. However, extreme weather condition may shift the beginning: Especially dry surface layer (seed- planting bed) may delay it by a week and longer; a cold soil slows down the sprouting in all crops but very sensitive are potatoes, maize, sunflower. Again, in 1998 winter cereals and rape start to regrowth already in the mid February in the opposition to 1996 with the start 3-4 weeks later

There are specified temperatures at that the growth of crop starts. Cereals, rape, peas, clover, alfalfa start growth at 0-5 °C, maize, sunflower 5-11. It should be stressed that the temperature of a soil may differ from air ones (measured in 2 m high), especially in spring, due to soil type, color, previous frost, water content.

Phenology of most crops could be related to altitude due to correlation of both to temperature and thus also to the sum of effective degrees. The number of days with temperature over 5 °C is about 200-250 up to 200 m altitude, and the number decreases by 8-9 days with every 100 m of a high. The effect of the field position (frost valleys, orientation of a slope to south or north etc.) must be taking into account when applying the relation to specific fields.

Table 9: *Phenological calendar of Czech republic (reasonable ranges)*

Crop	*Sowing date*	*Flowering date*	*Harvesting date*	*Remarks*
winter wheat	10.9-16.10	1.-23.6	22.7-27.8	
spring wheat	3.3-10.4	17.6-1.7	10.8-4.9	
winter barley	2.-20.9	26.5-18.6	13.7-10.8	
spring barley	5.3-14.4	10-28.6	20.7-25.8	
grain maize	10-28.4	15.7-4.8	10.9-12.10	
silage maize	22.4-5.5	22.7-10.8	10.9-2.10	
potato	15.3-5.5	30.6-27.7	12.6-15.10	early
sunflower	10-24.4	15.6-5.7	10.9-5.10	
winter rape	10.8-1.9	1.5-15.5	12.7-10.8	
spring rape	25.3-15.4	15.6-30.6	1.8-25.8	
sugar beet	26.3-12.4		28.9-25.10	

In Czech agriculture many agronomic recommendations are grouped according to production region. Rough classification is given in the table 10.

Table 10: *Basic classification of agricultural area into production regions*

production region	*altitude*	*average temperature*	*average sum of precipitation*
maize lowlands	about 200 m	over 9	under 500-600,

			strong evaporation
sugar beet midlands (further divided)	usually to 350, in favorite sites even over it	8-9	up to 600, in higher altitudes over 600
potatoes midlands to highlands (further divided to 2-3 regions)	350-500 and higher	6-8	upt to 700 –800
highlands	over 600 m	under 6	over 800

There have been specified „recommended terms of sowing“ for some crops grown in Czech Republic - see table 11. The different dates are given for production regions only for a few crops, where the term of sowing is known to strongly affect yields.

Table 11: *Recommended terms of sowing for some crops grown in Czech Republic*

Production region	*winter wheat*	*winterbarley*	*rye triticale*	*spring wheat oats*	*s.barley*	*winter rape*	*spring rape*	*spring fodder mixtures*
maize	20.9-15.10			early spring	March	maize and beet region 21.3-31.8	mid April	1.3-25.3
beet	20.9-10.10	mid Sept.				warmer potatoes reg. 20-25.8		11.3-26.3
potatoes	10.-30.9		2nd half of Sept.			colder pota-toes region 15-20.8		25.3-9.4
highlands	before 15.9					10-15.8		after 10.4

Table 11*: continuation*

	clover	*alfalfa*	*bean*	*peas horse*	*fodder beet*	*temporary grass*	*sugar beet*

				bean			
	from spring to summer (to 15.7)	from spring to summer (to 15.8)	1st half of May	early spring (the same as s.cereals)	start of April	mostly till the end of June	till 10.4

In farms the real days of sowing are shifted due to unfavorable weather (wet autumn of 1998 caused delay of several weeks in winter wheat sowing in the Czech Rep), delays in harvest of previous crops and other reasons. On the opposite e.g.: spring wheat could be sown as early as in February in the case of favorable weather (depends mostly on surface soil moisture allowing sowing).

Table 12 : *The phenological observation in Zdarske Hills region – farm fields (altitude 500-600 m, average precipitation and temperature 714 mm and 6 °C, resp) and in Prague-trials (340 m, 450 mm, 7,8 °C) in 1997. The site Zdarske Hills: Data for 1-3 cultivars and 1-3 sowing days.*

1997	**Zdarske Hills – RODOS radeco zone 2**								***Prague trial – RODOS radeco zone 1***		
	wint. wheat	*wint rye*	*wint tritic ale*	*wint. barley*	*spri barley*	*spri wheat*	*spri tritic ale*	*oats*	*Winter wheat*	*spring barley*	*spring wheat*
sowin g	12-18.10	4.-6.10	12.10	12.9	12.3-21.4	12.3	12.3	13.3-15.4	4.10	11.4	12.3
sprou ting	24.-28.10	15-20.10	24.10	22.9	20.3-29.4	3-4.4	6.4	24.3-12.5	14.10	-	3.4.
tilleri ng	20.3-16.4				19.5-30.5			30.5-10.6			
headi ng	18.6-29.6	30.5	9.6	30.5	18.6-10.7	18.6-11.7	18.6	18.6-11.7	1.6-4.6	18.6	7.6-11.6
flowe ring	29.6-11.7	20.6	29.6	10.6-20.6	30.6-20.7	29.6-22.7	29.6	30.6-20.7	8.6-15.6	30.6	16.6-22.6
matur ity	20.8-5.9	20.8-30.8	20.8-26.8	29.7-3.8	11.8-30.8	28.8-5.9	28.8	28.8-10.9	30.7-3.8	15.8	5.8-14.8

Table 13: *The comparison of phenological observation in Hnevceves – beet production region (altitude 265 m, average precipitation and temperature 594 mm and 8,3 °C, resp)*

and in Vysoke n.Jizerou – highlands (670 m, 1020 mm, 5,8 ℃) in the same year. Different cultivars and fields .

	Locality **Hnevceves**								
phenology cereals (peas)	***spring barley***					***peas***		.... ***oats***	
sowing	3.4	10.4	5.4	21.4	6.4	12.3	6.4	12.3	6.4
SPROUTING	**20.4**	**25.4**	**18.4**	**6.5**	**23.4**	**28.3**	**27.4**	**4.4**	**23.4**
tillering(1st flower)	6.5	9.5	7.5	17.5	8.5	8.6	6.6	29.4	10.5
heading (1st pod)	21.6	18.6	9.6	25.6	20.6	13.6	23.6	15.6	21.6
maturity	5.8	1.8	7.8	2.8	3.8	29.7	13.8	15.8	6.8

Table 13: *continuation*

	Locality: **Vysoke n. Jizerou**								
phenology cereals (peas)	***spring barley***						***peas***		***oats***	
sowing	24.4	24.4	24.4	27.4	28.4	6.5	6.4		6.4	
sprouting	4.5	5.5	7.5	3.5	8.5	15.5	19.5		16.5	
tillering(1st flower)	20.5	21.5	25.5	21.5	30.5	29.5	1.7		7.6	
heading (1st pod)	21.6	22.6	23.6	21.6	10.7	4.7	8.7		12.7	
maturity	17.8	17.8	19.8	27.8	17.8	31.8	17.9		27.9	

3.3.6 THARVEST - beginning and end of harvest of plants

Several interesting data are available (RICP, J. Petr et al., 1987) in table 14, which enables to define basic classification. The problem is not solved in full extent and collection of more precise data will continue.

Table 14: *Harvest intervals in cereals*

Production region	*The interval between 1st and the last harvest day*	*During 10 years the interval between the start and the and of harvest is*		
		1 x	5 x	9 x
		shorter than		
maize	10	13	21	29
beet	17	17	26	36
potatoes	18	16	26	36
highlands	17	12	26	38

3.3.7 WFHARVL - weighting factor for first part of harvest period

Some partial characteristics are available. It depends greatly on agrotechnics and specific demands of animal production in the certain farm (or a region). Generally, harvest of forage grasses (and clover, alfalfa) should be performed before heading to flowering, because of proportion of leaves to stems. In alfalfa 1st cutting amounts about 50 % of total year yield, in permanent grass 50-60 %, temporary grass 40-60 %. The 1st cut in beet production region of forage is performed 15.5-20.6, 2nd 20.7-20.8., the 3rd 1.9-15.9s

3.3.8 GRODILRATE - growth dilution rate (grass and hay only)

Growth dilution, especially in macronutrients is well described in main crops. It relates to growth rate. However, it must taken in account that while the value of dilution is an average for the whole biomass, some organs (leaves, harvestable organs) accumulate some nutrients. Plant stressed by drought, acid soils, toxic elements may have different course of dilution (less steep or even accumulation).

In fodder crops and grasses dilution of N (nitrate), K, C have been often investigated because of their effect on the health of farm animals.

Season dependent growth dilution rates and half-life values for the first radioecological region (lowest altitude) are constructed using the data obtained from our Slovak RODOS colleagues [20].

3.3.9 SOILMASS - soil mass per area of arable/pasture soil

The maximum depth of roots differ greatly in crops and soils. Generally, the root distribution (density) decreases exponentially with depth. The amount (intensity) of water and nutrients uptake has approximately similar shape with a shift to deeper layers in the case of full depletion of surface layers. Most of nutrients (except for calcium and magnesium) are absorbed from arable layer and from adjacent sub-arable layers down to 40-50 cm, even in deep rooted plants. Maximum (biologically possible) root depth of some species (e.g. 10 m in alfalfa) have no practical meaning in common prevailing soils in Czech Republic.

In table 15 (results of RICP) the realistic range of roots depth from where over 90 % of nutrients and water are absorbed are given. Capillary rise from unrooted zones may play some minor role only in mobile ions (nitrate) and water.

Table 15: *Realistic range of roots depth [cm]*

	Chernozem – degraded chernozem optimal or slightly suboptimal growth condition	*Deep fertile, loess soils, common conditions without extreme stresses*	*Shallow, sandy, coarse, high level of ground water, toxic levels of nutrients, acid soils, extreme drought, flooding, cold, biotic stresses (on fertile soils)*
winter wheat	110	100	70
w.barley	100	90	70
rye	-	90	80
spring barley	90	80	60
s.wheat	90	80	60
oats	90	90	80
sugar beet	130	110	-
winter rape	110	100	90
early potatoes	35-40	30	-

late potatoes	45-55	40	-
maize	120	100	70
peas	60	60	30
horse bean	90	90	50
clover (2 and more years)	110-150 (200)	120-150	- 120
alalfa (2 and more years)	120-250 (300)	120-220	- 150
grasses	extremely high proportion of roots are concentrated in surface layers, the proportion of deeper roots depends on species composition (clover, alfalfa vs. grasses) and intensity of fertilization		

3.3.10 Other nuclide independent parameters

Other necessary parameters has been collected starting from ENCONAN basic data (some values are shown in suppl. 3) and following the latest publication or research results. Fattening periods and feeding rates for animals are updated from [7, 11]. Some missing information still persists for human consumption where ref. [17] is used, but only a few data are available on the discrimination according to age categories. The same comment relates to parameters for delays for processing and consumption where the ENCONAN data are the only available. Further continuous co-operation with Czech expert teams is necessary. The data related to irrigation have in the Czech Republic only local significance and are relatively poor.

As for population data the profound investigation of the existing primary databases has been done and an attempt to generate gridded population data from the official data [14] was performed. Another correlation database with local information assigned to settlements identification had to be adjusted. The process is described in more detailed in [18] for purposes of quality assurance of the local data.

3.4Nuclide dependent FCM parameters (region dependant)

The RODOS methodology distinguishes for each radioecological region the following parameters:

- **danimal** – includes equilibrium transfer factors fodder-animal, biological halflives corresponding to the biological transfer rates, rate fractions
- **dfeed** – processing factors for feedstuffs
- **dfood** – processing factors for foodstuffs
- **dplant** – dry deposition velocities for plants, dep. velocity on bar soil, soil-plant transfer factors, resuspension factors

The new reliable local values derived especially for the Czech Republic were determined for a few cases only. Research activity in the field starts grow but we cannot expect it to cover the whole broad range. Some international research joint projects were launched (for example related to sorption of CS and soil vulnerability) which could afford some results in future. The expert study [19] prepared by specialist from State Health Institute reviews the potential local sources for collection of the parameters.

In the frame of ENCONAN calculations many data commonly accepted were extracted from outstanding references and prepared for its use in the ENCONAN calculations. Besides the data in suppl. 3 also detailed tables of concentration factors, transfer factors feed/animal product and other nuclide dependent data has been defined. In the same way as in RODOS the data are based on the ICRP recommendations.

Their format is slightly different (concentration factors correspond to FDMT transfer factors soil/plant, only in ENCONAN they are expressed in units Bq/g dry (or wet - for forage) vegetation per Bq/g dry soil). The tables are not shown in suppl. 3 because of large extent. They are presented in the supplement of the ref. [6].

Basic recommendation of the expert study [19] is to overtake the default RODOS data in the most cases and to concentrate only to those parameters which have evidently local character (for example processing factors for feedstuffs and foodstuffs). Some co-operation in this field has been established but it seems to be long term matter. The results of the investigation for the proper local data are summarised here in the supplement 4. These data were delivered to the Appendix E of the common joint report [22] on FDMT customisation in Central European countries.

3.5 Isotope dependent model parameters

The RODOS structure considers the following isotope dependent dose factors for all exposure pathways:

- ingestion
- inhalation
- external γ-exposure from the cloud
- external γ-exposure from radionuclides deposited on ground
- skin contamination

For each nuclide the organ doses of all 12 organs including effective dose are distinguished for all 5 age categories. The dose factors (except of cloud) are given for various integration times.

The research investigation in the Czech Republic in this field has concentrated mainly on extraction of the proper data from world-wide studies and follows the latest ICRP recommendations. A special attention is devoted to the parameters which are explicitly stated in the Czech government regulations for nuclear safety or in the Czech Atomic Law. It relates not only the nuclide dependent region dependent FDMT parameters, but also the isotope dependent FDM data.

The regulation [23] includes obligatory values for dose factors for ingestion and inhalation pathways based on the latest ICRP recommendations. The set of the dose coefficients for case of effective dose for inhalation and ingestion pathways were extracted from [23] and presented in the supplement of [18]. The obligatory values are checked with the default values used in RODOS in the process of RODOS accreditation for its use in the Czech Republic. Some results are included in the interim RODOS report [18].

4 Comment on late countermeasure data collected in the Czech Republic

Agricultural countermeasures: Soils

Database PUGIS of soil types for the Czech Republic has been developed in the Czech University of Agriculture (CUA) in Prague. The database is constructed on the basis of systematic soil survey in CR (historical data) and on the actual data collected recently on selected soil pits and it represents results of the 30 years research. The database PUGIS and its associated software includes:

- Digitised information from soil and environmental maps, especially geomorphology and slopes
- Soil characteristics (profile data, data from inventorying research)
- Extrinsic environmental characteristics
- Data from monitoring of research fields
- Soil exploitation, production, degradation, contamination etc.
- Attributes of heterogeneity of the soil cover
- Pedotransfer models
- Models of transport and pollutant transfer processes between soil and hydrosphere, biosphere and food chain
- Information about natural and anthropic factors and environmental loads

Basic classification (FAO – 1970) includes 36 types of soil (with further more detailed subdivision). For purposes of RODOS database it was necessary to reduce the number of the types. Czech RODOS team established collaboration with CUA and pay for expertise judgement of the problem of the soil type reduction. Reasonable criterion was defined on the basis of texture characteristics. But the expert needed another criteria which should express RODOS situation. We have received (April 1998) from Mr. S. Fesenko some tables, where mineral soils are divided into three groups according to their mechanical composition using N. A. Katchinsky classification routinely applied in Russia. He send also the following tables such an example:

Table 16*: An example of soil groups characteristics*

Soil groups	Soil types (used in Russia)	Hydrolytic acidity	% humus	Cation exchange capacity	Clay content
sandy, loamy sand	Soddy-podzolic, soddy-gleyed, soddy, light grey forest	3.5 – 6.5	0.5 – 3.0	3.0 – 15.0	< 20%

light loam, middle loam	Soddy-podzolic, soddy, grey and dark grey forest leached chernozem, podzolised chernozem	4.0 – 6.0	2.0 – 6.5	5.0 – 25.0	20-40%
heavy loam, clay	Dark grey forest, leach. chern., podzol. chern., typical and usual chern.	5.0 – 8.0	3.5-10.0	20.0 – 70.0	>40%
peat	Peaty, peaty-bogged, peaty-gleyed	3.0 – 5.0	5.0-30.0	20.0 – 200.0	

The table was delivered to CUA and was used such one of the selection tool during the expertise judgement. The main criterion resulting from the RODOS FCM requirements was established on the basis of texture:

Clay .... particle size : < 0.001 mm

Loam .... particle size : 0.001 mm – 0.5 mm

Sand .... particle size : 0.05 mm – 2 mm

As a result of the expertise study was reduction of the soil types into 6 categories:

p1 .... sandy

p2 .... loamy sand

p3 .... loam

p4 .... loamy clay

p5 .... clay

p6 .... peat

The classification is more detailed then RODOS requirements, because it is assumed to be used also for other research activities. For RODOS purposes the further reduction is done:

sand .... p1 + p2

loam p3

clay .... p4 + p5

peat p6

The data for RODOS purposes has been delivered in two special formats:

A. Vector layers : For each category p1, p2, ... , p6 the corresponding sets of polygons covering the whole territory of the Czech Republic are available. A new p7 category has been added (other : built-up areas, water, ...). The MATLAB tool has been developed for the purposes of partial visualisation (for example see fig. 5 from ref. [18] where complicated polygons of the p1 soil type – sandy – are demonstrated).

B. Intermediate gridded file: A special attention has been devoted to the construction of gridded environmental data necessary for the radioecological and countermeasure calculations within RODOS. Data on population surface density according to particular age categories, agricultural production, number of animals, soil types and other items has been extracted from various primary databases into the intermediate gridded file. It consists of 82 138 records, each record stands for tile 1 x 1 km and comprises many items characterising various properties on the tile (co-ordinates of the tile centre in JTSK system of co-ordinates, maximum altitude, identification of radioecological region, district number, average population according to age categories, surface and soil type characteristics, agricultural production data on the tile etc.). The grid continuously covers the whole surface of the Czech Republic and after its final transformation to geographical co-ordinates it should be continuously linked to neighbouring countries. The intermediate file serves partly for automatic generation of a new data item (correlation with the existing entities in IGF expressed by selection rules), partly for the final transformation to the required RODOS format and finally will facilitate the data transition to European database.

The structure of the intermediate gridded file is demonstrated here in the supplement 1. As for soil types, the variables p1 to p7 and pmax valid for each tile have the following meaning:

p1 .... *percentage of soil type p1 on the tile (light soil - sand)*

p2 ..... *percentage of soil type p2 (lighter middle textured soil)*

p3 ..... *percentage of soil type p3 (middle textured soil - loam)*

p4 ..... *percentage of soil type p4 (heavier middle textured soil)*

p5 ..... *percentage of soil type p5 (heavy soil - clay)*

p6 ..... *percentage of soil type p6 (peat , peaty - bogged, peaty- gleyed)*

p7 ..... *percentage of other surface (built-up and water areas, ...)*

pmax... *category of soil type from p1 to p7 prevailing on the tile (zero means the centre of tile is outside of the Czech Rep.)*

The record valid for a certain tile comprises also the number id of radioecological region and then the fraction of each soil type for each radioecological region can be computed easily.

Agricultural countermeasures: Resources and costs

The structure of the agricultural production in the Czech Republic has changed substantially since 1991 and deep changes in all fields are expected. Unfortunately, the process of restructuralisation is not so far well defined what results in deep recession of the branch. The main adverse features influencing agricultural production are:

- unclear owners relations
- high prices of chemical fertilisers
- lack of natural fertilisers and decreasing fertility of soil
- decreasing of sowing areas
- dramatic decrease of the numbers of animals

-

Then, the collection of data on costs, availability of proper equipment and labour resources needed for various countermeasure procedures has non-systematic character. Reliable data is not available now at a full extent and only some particular numbers were found (sometimes being mutually in contradiction). An attempt has been done to gather some information valid for the Czech Republic related to availability and costs of some items (lime, NPK fertilisers, manure, Prussian Blue). The responses to the questionnaire addressed to several potential external providers were rather poor. A few partial results were translated to Mr. Fesenko.

The limits for various food bans (and other various intervention levels, off course) are strictly defined in the Executive Regulation no. 184 [23] of the new Czech Atomic Law. The overview of the limits is given in [18] .

Agricultural countermeasures: Animal diets

The Czech RODOS team joined to the project [22]. The table which summarises the data on animal diets delivered to the document [22] is presented here in the supplement 4.

Decontamination

The proper local data on decontamination for RODOS LCMT customisation are not available at full extent in the Czech Republic. The following possible sources of the data were contacted:

- Governmental Board on Emergency Planing
- Ministry of Living Environment
- Institute of Civil Protection of CR
- Czech Army

Governmental Board on Emergency Planing is responsible for emergency management in the zone of emergency planning (up to 15 km from NPP). According to information given to RODOS team the main interest is laid on early countermeasure optimisation. The late countermeasures have lower priority and they are assumed to be applied ad hoc, according to the real situation.

Ministry of Living Environment has its own database system “HAVARIE” for emergency management of chemical incidents. The stress is laid on management of early effects and application of late countermeasures is not so far assumed. Some special decontamination techniques are included but no detailed information was provided. The first steps for possible future co-operation were rather tough.

Institute of Civil Protection of CR, Czech Army : The process of harmonisation of emergency planing with NATO and EU procedures is just starting. So far , only old obsolete data form the period of “cold war” are available. In common, the participation of the chemical troops on the potential decontamination activities following accident is planned.

5 Conclusion

The first step of RODOS FDMT customisation has been done. Many very useful connections with local providers and specialists has been established. Various local values of the model parameters were collected from miscellaneous sources. The areas of the missing data are specified and its future determination on the basis of co-operation with experts teams are suggested. At the same time the actualisation procedures are defined. The RODOS customisation process for the Czech Republic have to be submitted to continuous quality assurance process which have to lead to accreditation of the system for its use in the field of nuclear safety assessment.

New significant findings in the field could lead to changes in so far accepted strategy and some recalculations of input database. An example related to the new multi-parametric concept of the Czech territory regionalisation was given in the previous paragraph 2 and is based on the latest publication [3]. Application of the concept could cause to replace our present single - parametric definition of the radioecological regions (see suggestion on fig. 4 for case of the three zones). Figure 7 shows in more detailed the new regionalisation for the whole Czech Republic [3].

One of the main achievement of the customisation process in CR is preparation of input data processing subsystem for automatic generation (and then actualisation, too) of gridded environmental data. The original miscellaneous data were collected in rough format and reconstructed into an appropriate structure of gridded data. Set of conversion programs has been developed for this purposes. The gridded data are included in an intermediate gridded data file which consists of 82 138 tiles of dimension 1 x 1 km continuously covering the whole territory of the Czech Republic.

The data in a special national system of coordinates (JTSK) are to be transformed to the geographical coordinates and rebuilt to the form of

RIF files necessary for RoGIS database. The final step of environmental gridded data import into ROGIS was accomplished so far for the geographical page e014n49 (NPP Temelin inside) for population and agricultural products. The area e014n49 (one degree of longitude by one degree of latitude) is divided into 100 x 100 cels.

A lot of work is to be done and it is ongoing process dependent on the future available manpower. All map pages for the whole Czech Republic have to be created and linked to the neighbouring countries. The final goal is to transfer the data into the European database and provide its maintenance on the basis of the new annual statistics.

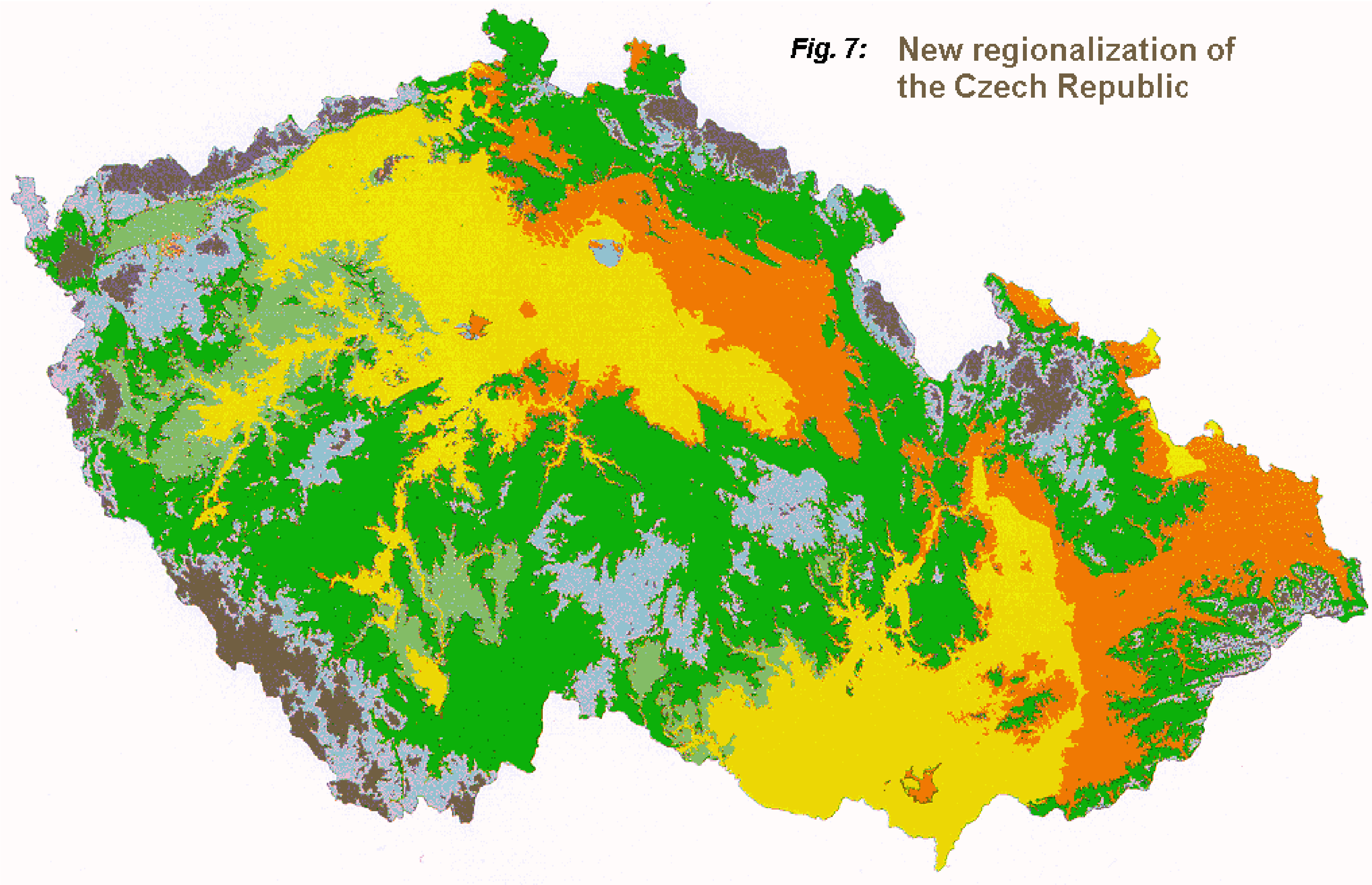
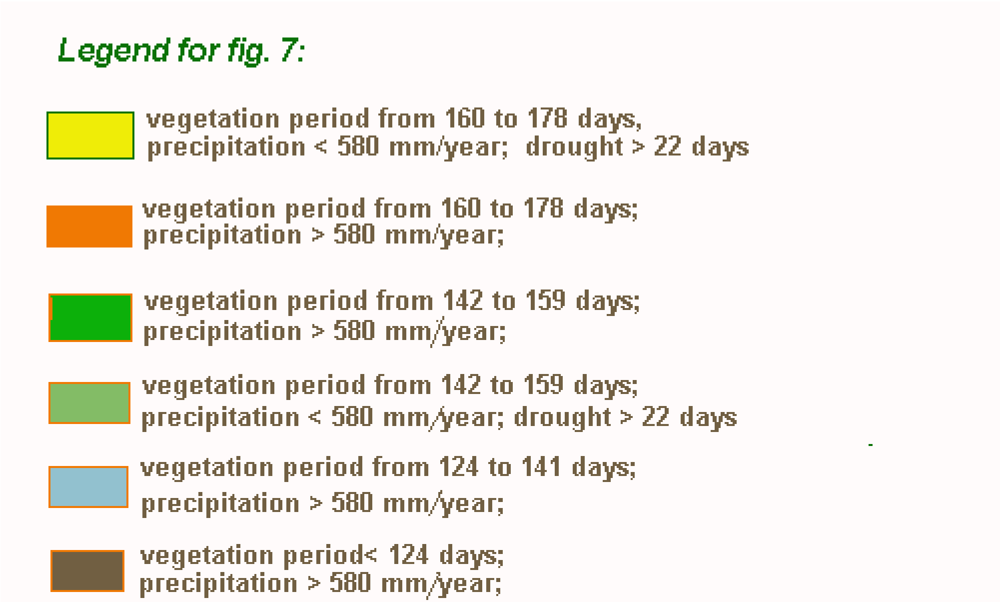


Fig. 7: New regionalization of the Czech Republic


Legend for fig. 7:
vegetation period from 160 to 178 days,
precipitation < 580 mm/year; drought > 22 days
vegetation period from 160 to 178 days;
precipitation > 580 mm/year;
vegetation period from 142 to 159 days;
precipitation > 580 mm/year;
vegetation period from 142 to 159 days;
precipitation < 580 mm/year; drought > 22 days
vegetation period from 124 to 141 days;
precipitation > 580 mm/year;
vegetation period< 124 days;
precipitation > 580 mm/year;

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SUPPLEMENT 1: Intermediate gridded file for CR (82 138 tiles)

d	x	y	nv	p1	p2	p3	p4	p5	p6	p7	pmax	c1	c2	c3	c4	c5	c6	c7	c8	cmax	g1	g2	...
....																							
....																							
3209	-723488.3125	-1047916.6250	292	0.00	0.00	99.98	0.00	0.00	0.00	0.00	3	0.10	0.00	22.24	0.00	27.76	4.49	45.40	0.00	7	....		
3410	-855560.1875	-1047920.1875	621	0.00	9.84	90.08	0.00	0.00	0.00	0.00	3	0.00	0.00	44.08	0.00	0.00	28.70	27.14	0.00	3	....		
3607	-591402.1250	-1047921.1250	862	0.00	91.57	8.40	0.00	0.00	0.00	0.00	2	0.00	0.00	1.19	0.00	0.00	4.19	94.58	0.00	7	....		
3602	-669041.0625	-1047923.0625	214	0.00	0.18	99.80	0.00	0.00	0.00	0.00	3	0.00	0.00	13.17	0.00	0.00	86.82	0.00	0.00	6			
3407	-801123.4375	-1047927.5625	413	0.00	0.00	99.95	0.00	0.00	0.00	0.00	3	0.00	0.00	67.43	0.00	0.00	32.52	0.00	0.00	3			
3100	-746680.5625	-1047932.8125	346	0.00	0.00	99.97	0.00	0.00	0.00	0.00	3	48.23	0.00	0.00	0.00	0.00	0.00	51.74	0.00	7			
3607	-614594.0625	-1047933.3125	324	0.00	0.00	69.26	0.00	30.72	0.00	0.00	3	20.81	0.00	48.36	0.00	0.00	25.09	5.72	0.00	3			
0	-513772.1563	-1047934.0625	362	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9			
3410	-878746.1875	-1047934.1875	688	0.00	92.82	0.00	0.00	0.00	7.09	0.00	2	0.00	0.00	0.00	0.00	23.24	0.00	76.68	0.00	7			
3208	-692234.0625	-1047938.3750	193	99.98	0.00	0.00	0.00	0.00	0.00	0.00	1	0.00	0.00	58.62	0.00	0.00	0.00	41.36	0.00	3			
3811	-536960.5000	-1047941.0625	725	0.00	62.88	37.07	0.00	0.00	0.00	0.00	2	0.00	0.00	16.63	0.00	0.00	46.54	36.78	0.00	6			
3407	-824312.7500	-1047943.1875	542	0.00	0.00	99.95	0.00	0.00	0.00	0.00	3	0.00	0.00	30.50	0.00	1.84	0.20	67.41	0.00	7			
3602	-637786.6250	-1047946.6875	288	99.98	0.00	0.00	0.00	0.00	0.00	0.00	1	0.00	0.00	0.00	0.00	23.66	0.00	76.32	0.00	7			
3202	-769872.1250	-1047949.0000	391	0.00	0.00	99.97	0.00	0.00	0.00	0.00	3	0.00	0.00	54.41	0.00	19.01	0.00	26.55	0.00	3			
3809	-560150.2500	-1047949.8750	1040	0.00	0.00	63.45	0.00	0.00	0.00	0.00	3	0.00	0.00	0.00	0.00	0.00	0.00	70.76	0.00	7			
3204	-715426.8750	-1047954.1875	272	0.00	0.00	99.98	0.00	0.00	0.00	0.00	3	10.87	0.00	88.95	0.00	0.00	0.16	0.00	0.00	3			
3410	-847500.7500	-1047958.2500	562	0.00	0.00	99.94	0.00	0.00	0.00	0.00	3	0.00	0.00	73.20	0.00	0.00	0.00	26.74	0.00	3			
3606	-660979.5625	-1047961.0000	288	0.00	0.00	98.59	1.40	0.00	0.00	0.00	3	0.00	0.00	24.00	0.00	5.21	0.00	70.77	0.00	7			

```
3212 -793062.8750 -1047965.1250 396  0.00  0.00 99.96  0.00  0.00  0.00  0.00 3  0.00  0.00 33.91  0.00  0.00  8.07 57.98  0.00 7
3100 -738619.3125 -1047970.2500 285  0.00  0.00 18.55  0.00  0.00  0.00 81.42 7 78.78  0.00  0.00  0.00  0.00 21.19  0.00  0.00 1
3607 -606532.8125 -1047972.0625 441  0.00 55.26 44.72  0.00  0.00  0.00  0.00 2  0.00  0.00 54.99  0.00  0.00  0.00 44.98  0.00 3
3410 -870687.2500 -1047972.5625 537  0.00 89.00  0.00  0.00  0.00 10.92  0.00 2  0.00  0.00 95.75  0.00  0.00  4.17  0.00  0.00 3
3801 -505712.6250 -1047975.1875 240  0.00  0.00 99.93  0.00  0.00  0.00  0.00 3  0.00  0.00 62.19  0.00  0.00 37.74  0.00  0.00 3
3208 -684172.5625 -1047976.1250 197 89.16  0.00  0.00  0.00 10.82  0.00  0.00 1  0.00  0.00 91.70  0.00  0.00  8.29  0.00  0.00 3
3407 -816252.6250 -1047980.8750 472  0.00 50.89 49.06  0.00  0.00  0.00  0.00 2  0.00  0.00 71.04  0.00  0.00  0.00 28.90  0.00 3
3801 -528900.4375 -1047981.5000 531  0.00  0.00 99.95  0.00  0.00  0.00  0.00 3  2.11  0.00 64.73  0.00  0.00 30.63  2.48  0.00 3
3607 -629725.2500 -1047985.0625 276  0.00  0.00 99.02  0.00  0.96  0.00  0.00 3  0.00  0.00  0.00  0.00 15.83  0.00 84.16  0.00 7
3202 -761811.1875 -1047986.5000 441  0.00  0.00 99.96  0.00  0.00  0.00  0.00 3  0.00  0.00  2.23  0.00 11.16  0.64 85.93  0.00 7
3811 -552089.6875 -1047989.7500 830  0.00 26.02 73.94  0.00  0.00  0.00  0.00 3  0.00  0.00  0.00  0.00 53.83  0.00 46.13  0.00 5
................
............. e.t.c. for all 82138 records
.....................
```

Identification:

d .... *district id*

x, y ... *S-JTSK coordinates (centre of tile)*

nv ..... *maximum altitude on the tile [m]*

soil type characteristics on the tile :

p1 .... *percentage of soil type P1 (light soil - sand)*

p2 ..... *percentage of soil type P2 (lighter middle textured soil)*

p3 ..... *percentage of soil type P3 (middle textured soil - loam)*

p4 ..... *percentage of soil type P4 (heavier middle textured soil)*

p5 ..... *percentage of soil type P5 (heavy soil - clay)*

p6 ..... *percentage of soil type P6 (peat , peaty - bogged, peaty- gleyed)*

p7 ..... *percentage of other surface (built-up and watter areas, ...)*

pmax... *kategory of soil type from P1 to P7 prevailing on the tale*

(zero means the centre of tile outside Czech Rep.)

Surface characteristics of the tile (according to database CORINE):

c1 ..... percentage of surface type C1 : urban and built-up areas

c2 ..... percentage of surface type C2: free country - non-agricultural

c3 ..... percentage of surface type C3: agricultural - arable ares, cropland

c4 ..... percentage of surface type C4: agricultural - lasting plants:gardens, vineyards, hop-gardens,..)

c5 ..... percentage of surface type C5: grassland and pasture -

c6 ..... percentage of surface type C6: mixed agricultural and shrubland

c7 ..... percentage of surface type C7: forests

c8 ..... percentage of surface type C8:water areas

cmax .. no. of category from C1- C8 with prevalent occurrence on the tile

(zero means the centre of tile outside Czech Rep.)

Other variables relating to agricultural production g1, g2, ... and population according to age categories a1, a2, ..., a6 for the tile follow

SUPPLEMENT 2 : District-average 1996 official agricultural production data (Czech Statistical Office)

For all 78 districts of CR, 82 observed products

Yield of product in [t] (10^3 kg) --- 82 observed products ------------------------>

District code	District name	District area [ha]	District population	R101S2 Wheat autum (yield in [t])	R102S2 Wheat spring (yield in [t])	R103S2 Rye (yield in [t])	R104S2 Barley aut. (yield in [t])	R105S2 Barley spr. (yield in t])	R106S2 Oats (yield in [t])	R107S2 Triticale (yield in [t])
3100	Praha hl.m.	49640,31	1214174	17641,2	2532	0	1313,1	8875,7	2237,5	366,8
3201	Benesov	150298,36	90731	67191,8	2880,8	9941,4	16367,5	31072,7	5847,6	5623,2
3202	Beroun	66190,48	75859	23820,2	2078,4	706,8	2615,1	14481	1632,9	523
3203	Kladno	69147,53	149407	58486,3	7415,7	459,6	1996,6	49267,2	535,2	0
3204	Kolin	84615,81	97782	74288,8	4011,2	1096	4151,6	32007,6	3431,1	986,7
3205	Kutna Hora	93724,18	78938	63964,9	5185,5	1848	15206,3	23127,5	2680,2	2793,4
3206	Melnik	71238,75	94402	50451,5	6740,8	2395,9	5263,8	35272,3	1928	851,8
3207	Mlada Boleslav	105776,72	111671	79889,3	6734,9	5913	10582,7	27150,4	1990,3	2096,5
3208	Nymburk	87601,91	82714	74208,5	1245,9	1162,3	8157,6	35459,2	1334,6	653
3209	Praha-vychod	58410,99	92510	42487,5	5575,3	797,1	4998,4	21380,1	1603,8	680,2
3210	Praha-zapad	58627,63	74911	37797,7	2052,3	588,5	1773,9	20622,9	2706	555,4
3211	Pribram	162800,13	108805	53405,4	773	3207,5	15010	21427,6	3341,3	633,6
3212	Rakovnik	93028,91	55152	49220,5	3226	665,3	5847,6	20886,8	2640,6	709,3
3301	Ceske Budejovice	162542,17	173386	73576,4	774	2410,8	12931,9	23925	4602,4	980,5
3302	Cesky Krumlov	161491,47	57388	14371,9	675,2	2193,8	2964,4	11601,9	2289,4	0
3303	Jindrichuv Hradec	194380,78	93048	56348,9	2830,6	9891,6	5988,6	33338	8014,9	1300,5
3304	Pelhrimov	128958,02	74614	35337,5	2970,6	12079,6	5827	47540,5	6946,8	0
3305	Pisek	113806,25	72074	63050,1	997	3712,7	13912,5	14342,7	2776,5	81,9
3306	Prachatice	137478,13	50985	12837,4	934,2	1546,3	1890,1	7374	2416,2	763,7
3307	Strakonice	103174,05	71978	57062,1	616,5	6929	13816,3	20636,3	4642,1	1038,1
3308	Tabor	132709,57	104030	61960,6	928,5	11473,1	10415,4	29357,6	10591,5	920,4
3401	Domazlice	114003,54	58729	59364,5	1417,3	4384,8	13778,7	13061,2	6354,3	474,8

3402	Cheb	93262,95	86932	15967,6	538,3	1505,2	2557,2	7300,8	1942,6	278,8
3403	Karlovy Vary	162803,12	122430	21995,7	123,6	3509	3414,5	11909,5	1761,2	1463
3404	Klatovy	193946,81	89767	59878	2453,6	5667,9	18814,9	21133,5	4064,4	709,3
3405	Plzen-mesto	12474,38	173008	7095,4	500,3	0	2062,7	2392,7	305,7	16
3406	Plzen-jih	107978,92	68149	53412,6	4320,5	3596,3	16525,1	19477,8	7768,1	0
....	e.t.c. for all 78 distr. ..	....	....	....	....	....	....	....	....	....

SUPPLEMENT 3: FCM input data from former model ENCONAN

Vegetation periods, consumption parameters, yields characteristics

Product	Beginning of plant growth $\mathbf{t_{veg1}}$ [d] (Jul. day)	Average harvest time $\mathbf{t_{skl}}$ [d] (Jul. day)	Delay to consumption $\mathbf{t_{zd}}$ [d]	End of consumption $\mathbf{t^2_{konz}}$ [d]	Yield of upper leaves area $\mathbf{Y_{MS}}$ [kg/m^2]	Dry contents fraction **SUS**	Net yield of product $\mathbf{V_c}$ [kg/m^2]
leafy veg. spring	1.5. (121.0)	15.6. (166.0)	1.0	do 30.8. 242.0	1.46	0.08	1.46
leafy veg. autumn	1.6. (152.0)	30.9. (273.0)	1.0	up 31.12.	3.20	0.12	3.20
root vegetables	1.5. (121.0)	30.9. (273.0)	1.0	up 31.12.	0.40	0.16	3.40
fruit vegetables	1.5. (121.0)	31.7. (212.0)	1.0	do 31.12.	2.71	0.06	2.31
cereals - wheat	20.4. (110.0)	31.7. (212.0)	consumption new: 105.0	31.12.	1.15	0.86	0.51
potatoes	10.5. (130.0)	30.9. (273.0)	1.0	31.12.	0.30	0.21	1.83
fruit (only root transport)	1.5. (121.0)	30.9. (273.0)	0.0	up 31.12.	0.90	0.06	0.90
barley spring	20.4. (110.0)	31.7. (214.0)	105.0	365.0	0.95	0.86	0.46
maize (sillage)	1.6. (152.0)	20.9. (263.0)	0.0	365.0	3.40	0.31	3.40
sugar beet	10.5. (131.0)	20.10. (293.0)	0.0	365.0	2.00	0.22	3.49
grass - 1. harvest	15.4. (105.0)	10.6. (161.0)	0.0	365.0	2.19	0.18	2.19
grass - 2. harvest	11.6. (162.0)	31.7. (214.0)	0.0	365.0	1.09	0.18	1.09
grass - 3. harvest	1.8. (215.0)	15.10. (288.0)	0.0	365.0	0.37	0.18	0.37

SUPPLEMENT 4: FDMT data sets for the radioecological regions of Czech Republic: SUMMARY for purposes of joint report [22] The tables are numbered according to convention in APPENDIX E of [22]

Majority of nuclide dependent data and data having character of physical constants are taken from the default database of FDMT for Central European conditions. In the following text only data with significant local character are presented. The rest of data, for which the reliable local values are not available, are assumed to be substituted by the default values. The same holds true also for case of incomplete set of items in the particular tables.

lant species	Harvest	Yield (kg m^{-2})
Winter wheat	20.7-15.8.	0.51
Spring wheat	1.8.-15.8.	0.44
Winter barley	5.7.-20.7.	0.51
Spring barley	25.7.-10.8.	0.44
Triticale	2.8.-10.8.	0.41
Oats	1.8.-7.8.	0.33
Rye	18.7.-14.8.	0.39
Maize	10.9-30.9.	3.55
Corn cobs	1.10.-15.10	0.84
Beet	1.10-10.11.	4.25
Beet leaves	1.10.-10.11.	d
Potatoes (early)	10.6.-15.7.	1.80
Potatoes (late)	15.8.-15.9.	2.10
Rape	15.7.-30.7.	2.62
Leafy vegetables	1.6.-10.11.	2.50
Fruit vegetables	1.8.-30.10.	1.30
Root vegetables	1.8.-31.10.	2.10
Fruit	1.7.-20.10.	d
Berries	5.6.-10.7.	d

Table 3a: Times of harvest and yields Y_i (fresh weight) of the crops considered in FDMT: Specific values for radioecological region 1 (lowland) of the Czech Republic, d ... FDMT defaults

Note on table 3:

Source on times of harvest – available phenological data, RIAP and ARI expertise study.

Source on yield values – „Final figures on Crop Yields Harvested in the Czech Republic“, 1997, Czech Statistical Office. The values are constructed from averaged district values, can be influenced by the 1997 flooding events.

Plant species	Harvest	Yield (kg m^{-2})
Winter wheat	10.8.-30.8.	0.41
Spring wheat	10.8.-30.8.	0.32
Winter barley	1.8.-15.8.	0.39
Spring barley	10.8.-30.8.	0.39
Triticale	9.8.-15.8.	0.36
Oats	20.8.-15.9.	0.37
Rye	20.8.-15.9.	0.34
Maize	20.9.-15.10.	3.00
Corn cobs	x	
Beet	10.10.-25.10.	3.85
Beet leaves	10.10.-25.10.	d
Potatoes (early)	x	
Potatoes (late)	1.9.-20.10.	2.31
Rape	1.8.-15.8.	2.45
Leafy vegetables	10.6.-10.11.	2.40
Fruit vegetables	1.8.-30.10.	1.10
Root vegetables	1.8.-31.10.	2.10
Fruit	1.7.-20.10.	d
Berries	5.6.-10.7.	d

Table 3b: Times of harvest and yields Y_i (fresh weight) of the crops considered in FDMT: Specific values for radioecological region 2 (midland) of the Czech Republic; d ... FDMT defaults; x ... growing not recommended

Plant species	Harvest	Yield (kg m^{-2})
Oats	4.9.-15.9.	as midland - o
Rye	1.9.-15.9.	as midland - o

Table 3c: Times of harvest and yields Y_i (fresh weight) of the crops considered in FDMT: Specific values for radioecological region 3 (highland) of the Czech Republic; o ... reliable data not available

Radioecological zone	Plant	Harvest time 1st cut 20.5.-10.6.	Harvest time 2nd cut 15.7.-25.7.	Harvest time 3rd time 25.8.-10.10.	Total yield [kg.m^{-2}] f.w.
lowland < 450 m	grass intensive	1.85	1.55	0.80	4.20
	grass extensive	1.15	0.85	0.5	2.50
	alfalfa + clover	2.00	1.70	0.90	4.60
midland <450;700>	grass intensive	1.65	1.25	0.60	3.50
	grass extensive	0.95	0.75	0.50	2.20
	alfalfa + clover	1.7	1.4	0.70	3.80
highland > 700 m	grass intensive	1.40	1.20	0.30	2.90
	grass extensive	0.95	0.65	0.30	1.90
	alfalfa + clover	1.50	1.20	0.60	3.30

Table 3d : Times of harvest and yields for fodder crops considered in FDMT: Specific values for radioecological region 3 (highland) of the Czech Republic

Source : Research Institute for Fodder Crops, Troubsko near Brno

radioecolo-gical region	plant	d a t e and yield						
lowland	grass i	date	1.1.	15.3.	15.5.	15.7.	10.10.	1. 11.
< 450 m		yield	0.002	0.004	1.15	0.85	0.50	0.04
	grass e	date	1.1.	15.3.	15.5.	15.7.	10.10.	1. 11.
		yield	0.001	0.002	1.00	0.50	0.20	0.02
midland	grass i	date	1.1.	15.3.	15.5.	15.7.	10.10.	1. 11.
< 450 ,700>		yield	0.002	0.004	0.95	0.75	0.50	0.04
	grass e	date	1.1.	15.3.	15.5.	15.7.	10.10.	1. 11.
		yield	0.001	0.002	0.90	0.35	0.15	0.03
highland	grass i	date	1.1.	15.3.	15.5.	15.7.	10.10.	1. 11.
> 700 m		yield	0.001	0.003	0.95	0.65	0.30	0.005
	grass e	date	1.1.	15.3.	15.5.	15.7.	10.10.	1. 11.
		yield	0.001	0.002	0.70	0.50	0.25	0.025

Table 4: Yield of pasture grass (kg.m^{-2} f.w.) as a function of the time of year for CR conditions (source: RIFC)

Table 4 : Leaf area indices for other plants :

Radzone 1 : undertaken from SK-I region of Slovak Republic

Radzone 2 : RODOS defaults

Radzone 3 : undertaken from SK-III region of Slovak Republic

Note on table 4 : Undertaken values are assumed to be modified by known maximum LAI values as a function of yield. Corresponding table is presented in the report on FDMT customisation in CR.

Table 5 : Season dependent growth dilution rates and half-lives for grass and alfalfa (or clover) :

Radzone 1 : undertaken from SK-I region of Slovak Republic

Radzone 2 : RODOS defaults

Radzone 3 : undertaken from SK-III region of Slovak Republic

Animal	**Feedstuff**	**Intake rate** (kg.d^{-1} fresh weight)	
		low land	**midland**
Dairy cow with milk production >5000 kg.y^{-1}	grass	4[a,c]	25[a]
	clover	0	25[a]
	alfalfa	30[a]	0
	maize silage	20	5
	grain	7	5
	pulps	5	0
	straw*	2	2
Dairy cow with milk production <5000 kg.y^{-1}	grass	8[a,c]	30[a]
	clover	0	20[a]
	alfalfa	20[a]	0
	maize silage	15	0
	grain	4	3
	pulps	2	0
	straw*	2	2
Calf	milk substrate	3	3
	hay	1	1
	grain	1	1
	straw*	1	1
Beef cattle[y]	grass	0	40[a]
	alfalfa	10[a]	0
	grain	6	2
	maize silage	28	5
	straw*	6[b]	6[b]
Sheep	grass	0	10[a]
	grain	0	1
	straw*	0	1
Lamb	grass	0	5[a]
	grain	0	0.3
	straw*	0	0.5
Goat	grass	0	12[a]
	grain	0	1
	straw*	0	1
Horse	grass	30[a]	30[a]

	grain	1	1
	straw*	3	3
Red deer	grass ext.	10[a]	12[a]
	grain	1	1
Fallow deer	grass ext.	5[a]	6[a]
	grain	0.5	0.5
Rabbit ext.	grass	0.3[a]	0.3[a]
	grain	0.1	0.1
	straw*	0.2	0.2
Rabbit intens..	grain 0.2	0.2	
Pig	winter barley+ wheat	3	3
Hen, chicken	winter wheat	0.1	0.1

[a] Values given are for the vegetation period; during the winter (lowland 200, resp. midland 230 days) an equivalent dry matter intake with hay or silage is assumed (winter season for beef cattle and deers is about 30 days shorter), [b] Values given are for the winter period only, [c] Hay only, * Bedding, not for feeding, [x] Lowland mainly sheded, midland mainly pasture, [y] Lowland 30 % pasture, midland 80 % pasture, [z] Spring and autumn only.

Table 8: Feeding diets for animals : values for the Czech Republic conditions
(Source : Research Ins. for Animal Production)

month of feeding feedstuffs [kg,l/day]	1	2	3	4	5	6
wheat	0,4	0,4	1,1	1,1	1,3	1,3
barley	0,3	0,3	0,75	0,78	1,3	1,3
dry milk	< 0,1	0,08	-	-	-	-
whey	-	2,5	2,5	2,5	2,5	2,5

Table 8a: Time dependent feeding rates for pigs (former data used in CR for local ingestion model ENCONAN)

Animal product	foodstuffs	$\mathbf{t_{zdp}}$ [days]	$\mathbf{f_1}$ adults/ child<1
	fresh milk +	4	0,46 / 0,059

milk	cream		
	cheese	30 - 4 x 30	0,22 / 0,028
	dry + condensed milk	30 - 9 x 30	0,14 /0,89
	curd + other	15	0,18 / 0,023
meat	beef	30	
	pork	30	
	poultry	30	
eggs	eggs	14	

Table 13 : Time dealys to consumption t_{zdp} in days and consumption fraction f_1 of foodstuffs p in the value of the original animal product b to total consumption of the product (for age categories adults + child<1)
Source of data: former data used in CR for local ingestion model ENCONAN

Foodstuffs [kg, l / y]	0 - 1	Age 1 - 7	category 7 - 12	[year] 12 - 17	adults
leafy veg. spring	1.15	2.20	2.77	3.47	3.75
leafy veg. autumn	4.37	8.36	10.53	13.19	14.25
root vegetables	7.82	14.96	18.84	23.60	25.50
fruit vegetables	9.66	18.48	23.27	29.15	31.50
cereals - wheat	14.8	61.1	101.9	140.9	157.0
potatoes	4.4	36.6	50.7	77.1	80.0
fruits	9.9	33.6	45.4	55.9	45.0
milk	242.7	360.1	383.4	333.8	248.0
beef	3.8	14.9	20.7	23.2	21.5
pork	1.1	7.6	16.3	19.7	39.5
poultry	0.3	7.3	8.3	14.3	12.0
other kinds of meat	-	2.4	3.3	3.4	3.7

Table 14 : Age – dependent Czech consumption rates
Source of data: former data used in CR for local ingestion model ENCONAN

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