

RAKIP

risk assessment modelling & knowledge integration platform

anses
French agency for food, environmental
and occupational health safety



BfR
Bundesinstitut für Risikobewertung

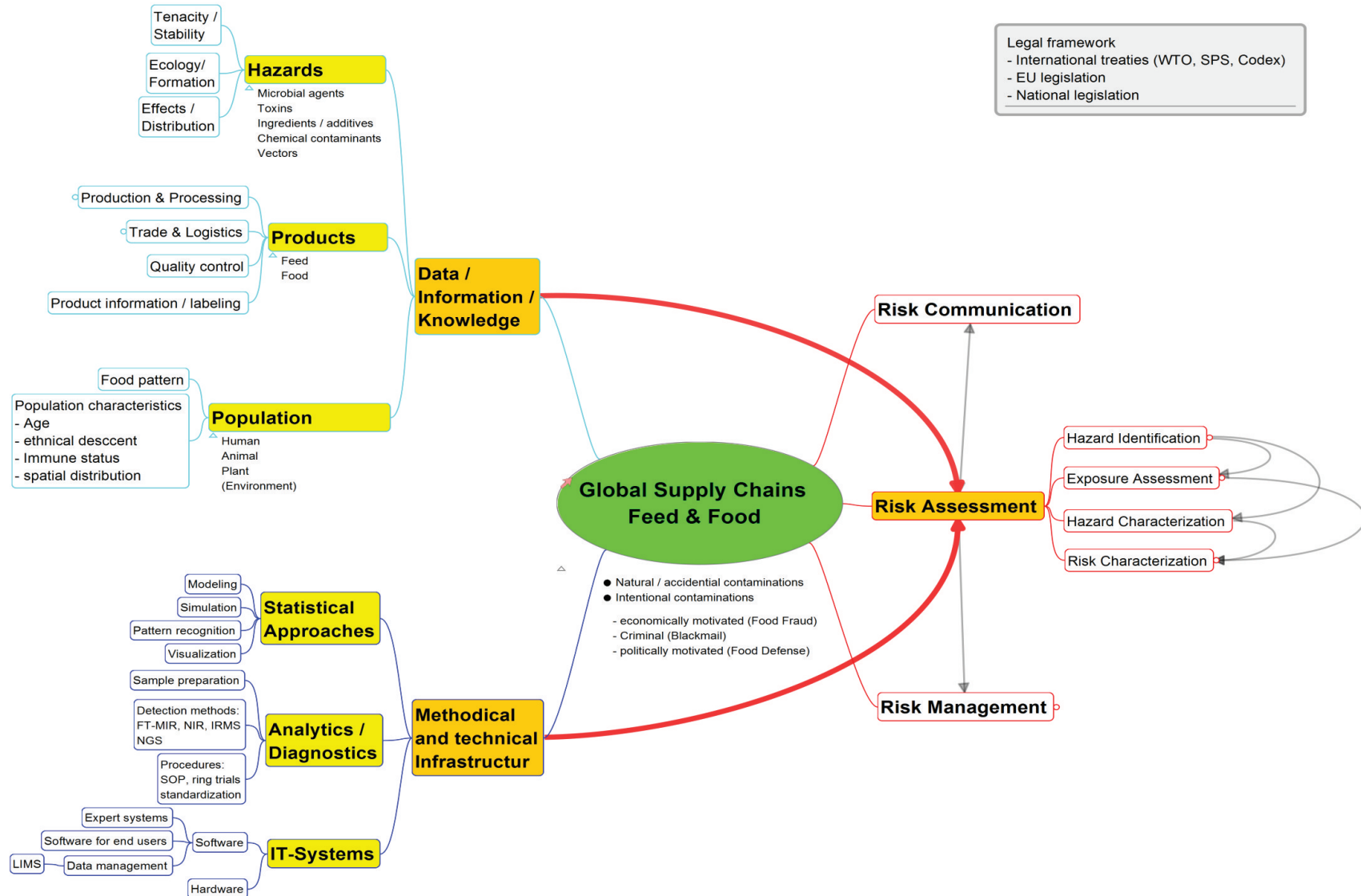
DTU Food
National Food
Institute



Risk Assessment Modelling and Knowledge Integration Platform (RAKIP)

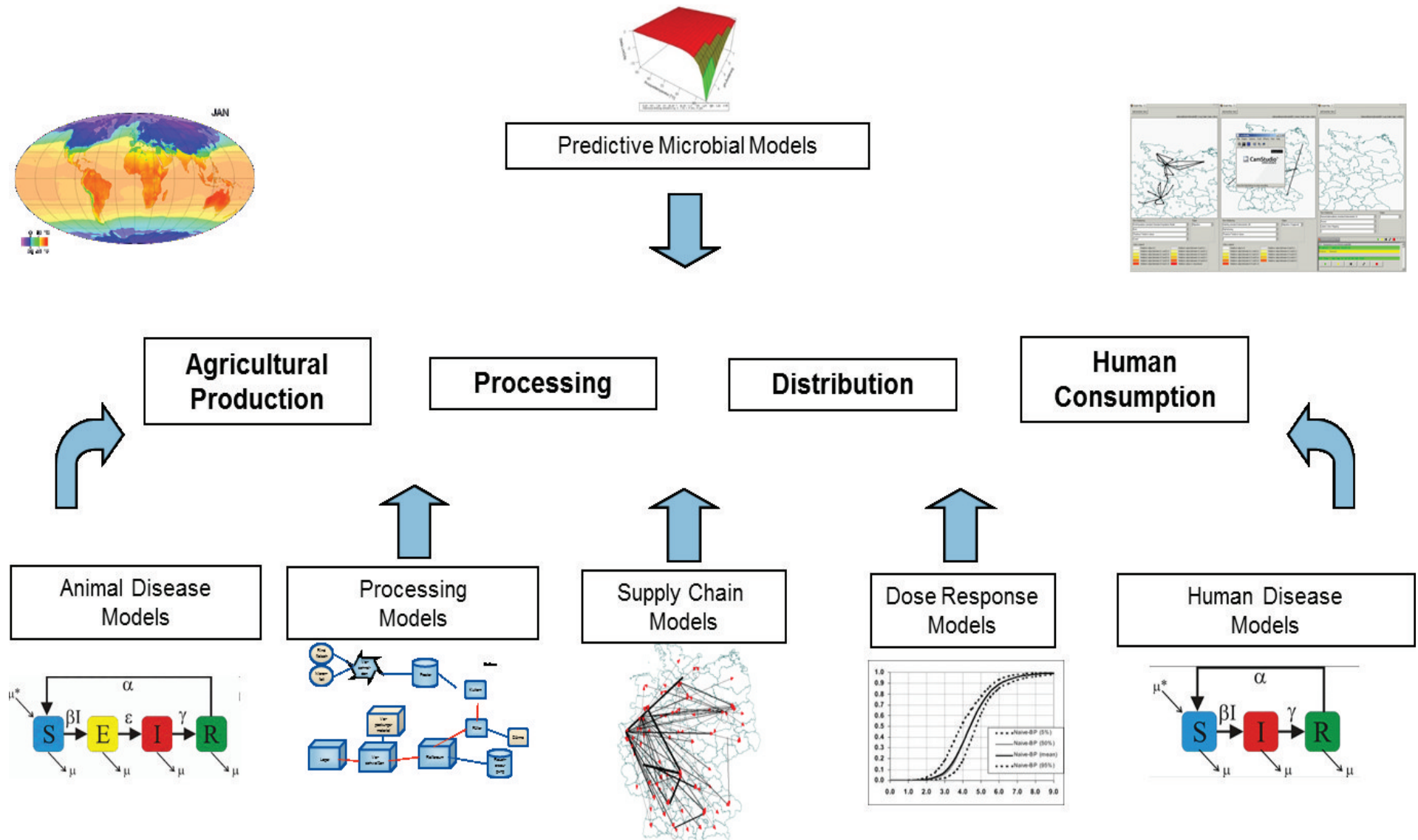
Matthias Filter

Global Supply Chains and Risk Assessment



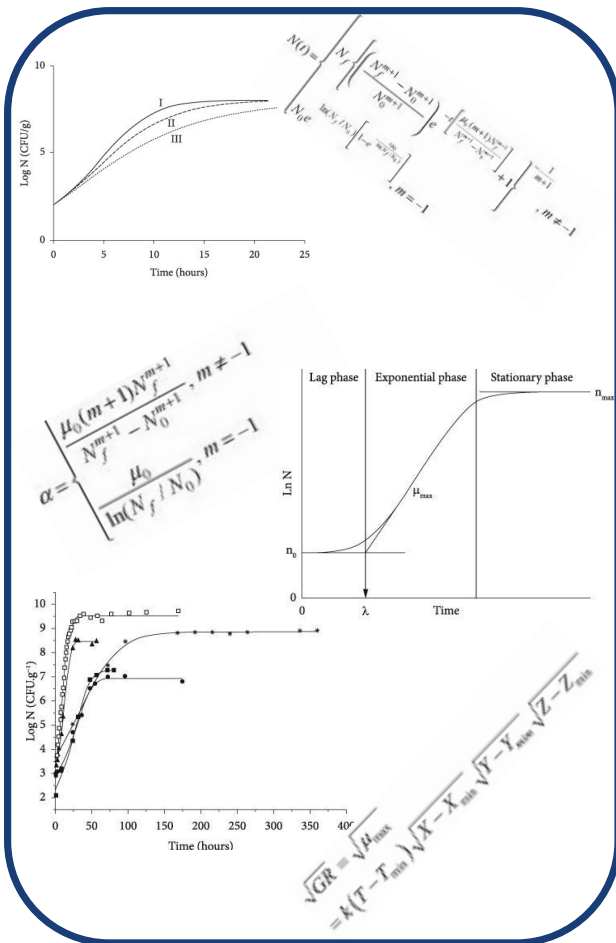
Risk Assessor's Needs

DATA, MODELS and TOOLS !



Current Situation

1. Plenty of data and models published



2. Several software tools for model based predictions and simulations



3. However...

- NO common FORMAT to describe models / data
- => NO information exchange between software tools
- FEW open-source software solutions
- => FEW models implemented into ready-to-use tools
- => Re-use of EXISTING knowledge HAMPERED

Issues with Model Re-implementation

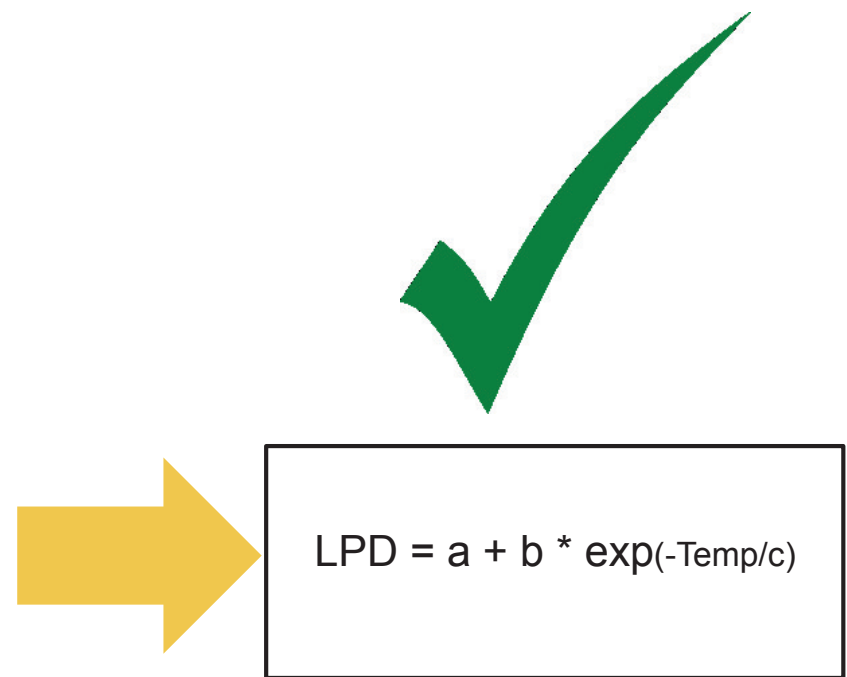
e.g. typos in model equations / formulas

LPD. Researchers have proposed that bacterial LPD is related to the time required for cells to adjust physiologically to a new environment (2, 3). In the case of spore-forming organisms, LPD would also include the time required for spores to germinate and the time required for the resulting vegetative cells to adjust to growth in the food matrix. Baranyi et al. (3) developed a dynamic growth model that includes a mechanistic parameter for LPD, and the model was used to describe LPD. For the majority of bacterial pathogens, the LPD has been shown to decrease with increasing temperature, and a similar trend was observed for *Salmonella* Sterne and Ames K0610. The LPD significantly decreased from 53 h at 18°C to 6.8 h at 44°C (Table 2 and Fig. 2). This distribution of LPD can be described with an exponential model (equation 2).

$$LPD = a + b^{(-temp/c)} \quad (2)$$

where $a = 2.3573$, $b = 3.47E8$, $c = 11.0396$, and $R^2 = 0.96$.

The observed LPD for Ames K0610 was within or close to the 95% confidence intervals for the Sterne secondary model (Fig. 2).



Issues with Model Re-implementation

e.g. erroneous re-implementation

The screenshot shows a software interface for model definition. The 'Microbial Data' tab is active. The 'Model Properties' section includes: Model type (radio buttons for primary, secondary, primary (secondary)), Formula from DB (Juneja_2010_GroundBeef_BacillusAnthracis), Formula Name (Two Phase Linear Inactivation Model with intersect time-Juneja 2010 (v1429275346762)), Formula (Value=Y0-(Time-Time_intersect)/D2*(Time>Time_intersect)-(Time/D1)+(Time-Time_intersect)/D1*(Time>Time_intersect)), and Boundary Conditions. A parameter table is shown below:

Parameter	Unit	Independent	Value	...	Min	Max	Description
Value*	Number Content (count/mass) -> log10(count/g)	<input type="checkbox"/> Value			7.0	10.0	bacterial population at time t -log10() transformed
D1	Time -> min	<input type="checkbox"/>	0.088				D-value of first rate equation
D2	Time -> min	<input type="checkbox"/>	442.3				D-value of second rate equation
Time*	Time -> min	<input checked="" type="checkbox"/> Time			0.0	0.5	Time
Time_intersect	Time -> min	<input type="checkbox"/>	0.35				time point of intersection of two linear inactivation rate
Y0	Number Content (count/mass) -> log10(count/g)	<input type="checkbox"/>	7.0				initial bacterial population -log10() transformed

Annotations with arrows point to: 'Value*' (units), 'Time*' (units), 'Time_intersect' (values), 'D1' (values), 'D2' (values), and 'Y0' (values). The 'Formula' field contains a complex mathematical expression. The 'Goodness of fit' section includes fields for R², AIC, RMS, and BIC. A reference is provided at the bottom: Juneja, Vijay K., 2010, Thermal inactivation of Bacillus anthracis Sterne in irradiated ground beef heated in a water bath or cooked on commercial grills.

annotations

formulas

units

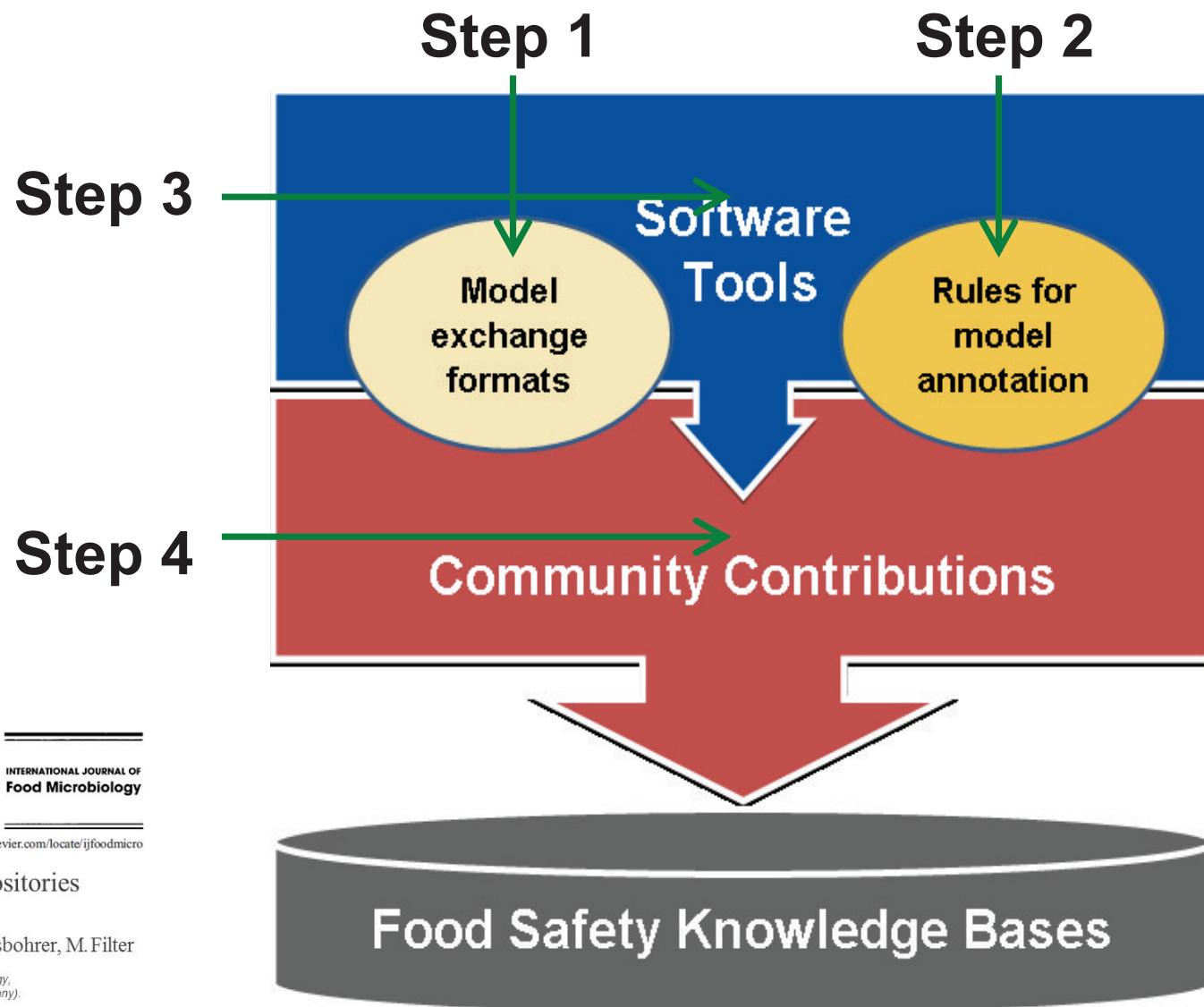
values

RAKIP Vision

Community-driven, curated repositories of food safety models / model modules (Food Safety Knowledge Bases)



RAKIP Approach



Available online at www.sciencedirect.com



International Journal of Food Microbiology

INTERNATIONAL JOURNAL OF
Food Microbiology

www.elsevier.com/locate/ijfoodmicro

A strategy to establish Food Safety Model Repositories

C. Plaza-Rodriguez, C. Thoens, A. Falenski, A. Weiser, B. Appel, A. Kaesbohrer, M. Filter

Federal Institute for Risk Assessment, Department Biological Safety, Unit Epidemiology, Zoonoses and Antimicrobial Resistance, Max-Dohrn-Straße 8-10, 10589 Berlin, (Germany).

<http://www.researchgate.net/publication/273791203> A strategy to establish Food Safety Model Repositories

RAKIP: Project

- Two years ago ... a discussion at the ICPMF9 conference
- One year ago ... a proposal for a tri-lateral funded collaboration project between ANSES, DTU, BfR
- January 2017: start of RAKIP !



Director General ANSES
Mrs. Caroline Gardette
President BfR
Prof. Dr. Dr. Andreas Hensel
Director National Food Institute DTU
Dr. Christine Nellenman

04/22/2016

Project Proposal "Joint Modelling and Knowledge Integration Platform"

Dear Directors,
Dear President,

we, the signing ANSES, BfR and DTU research scientists, approach you today with a request to initiate an internally funded tri-lateral scientific capacity building project addressing key objectives of the ANSES-BfR-DTU collaboration agreement.

The collaboratively developed project proposal specifically aims at sharing scientific and technical expertise in the area of food safety risk assessment and the piloting of a shared, curated risk model knowledge base. Such infrastructure will facilitate the efficient exchange of data and model-based resources between the three institutes and promote future joint risk assessments on various public health issues. In addition, this project generates a pilot system that serves as a critical reference for several, planned EU grant applications aiming at the harmonization and adoption of model-based risk assessment solutions.

The project outline and expected results are detailed in the attached project summary.

In advance, the signees want to thank for a favourable examination and timely decision.

Yours sincerely

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RAKIP: Results

AGREEMENT

Conceptual framework

- ✓ Terms and concepts
- ✓ Schemata detailing processes
- ✓ Harmonized vocabulary
- ✓ Glossary
- ✓ Metadata description
- ✓ Controlled vocabularies

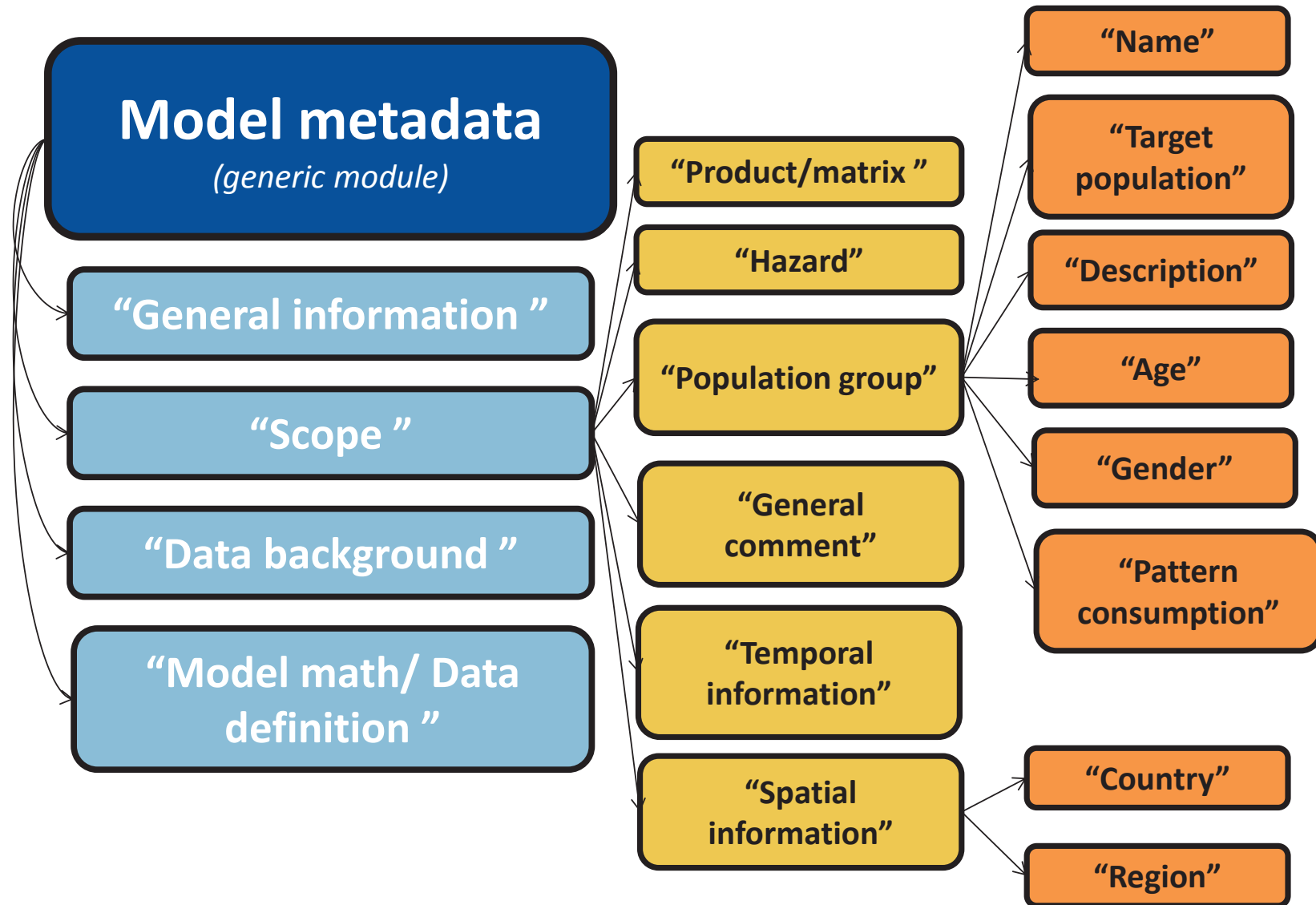


RAKIP Results

Glossary

- Collaborative platform: Infrastructure set up by ANSES for the RAKIP project that allows the exchange of files, information and, supports communication.
- Consumption model: A consumption model consists of a set of one or more population groups, with each group having an associated consumption pattern and an exposure type.
- Curation: A curation process for models aims to classify models according to certain quality criteria. These quality criteria must be defined. Depending on the classification, the End-users of the model can e.g. judge how reliable the model might be.
- Data-driven Knowledge: Knowledge derived from data obtained from different sources including published and unpublished studies, national or international official data, risk assessments, expert opinions, surveys and questionnaires.
- Dose-response model: Model describing the relationship between the magnitude of exposure (dose) to a hazard and the severity and/or frequency of associated adverse effects (response).
- End-users: Person who ultimately applies or is intended to ultimately apply a model. In this aspect several levels of End-users can be defined:
 - Non-expert user: Person who intendeds to use the model mainly for making predictions without too much interest in the Modelling process.
 - Expert user: Person who is interested not only in the model predictions, but also in the Modelling process, including data, Model Equation, Fitting process, etc.
- Evaluation data: Experimental/Observational data that have not been used for generation of the to-be-evaluated Fitted model. Its purpose is to evaluate the performance of the Fitted model.
- Experimental/Observational data: Measurement values obtained in experiments or generated in observations. Can be used in the Fitting or Validation procedure.

RAKIP Metadata collection as basis for the FSK-ML



RAKIP Metadata collection as basis for the FSK-ML

General Information	1	Study / Data / Model Name	1			
		Source	0:1			
		Identifier	1			
		Creator(s)	1:N	vCard 4.0 standard	1	
		Date	1:N	Creation date	1	
				Last modified date	0:N	
		Rights	1	Rights	1	
		Availability	1			
		URL	0:1			
		Format	0:1			
		References	1:N	is_reference_description?	1	
				Publication type	0:1	
				Publication date	0:1	
				PubMed ID	0:1	
				Publication DOI	1	
				Publication Author List	0:1	
				Publication Title	1	
				Publication Abstract	0:1	
				Publication Journal / Vol / Issue, etc.	0:1	
				Publication Status	0:1	
		Publication website	0:1			
		Comment	0:1			
		Language	0:1			
		Software	0:1			
		Programming language	0:1			
Model category	0:1	Model Class	1			
		Model Sub-Class	0:N			
		Model Class comment	0:1			
		Basic process	0:N			
Status	0:1					
Objective	0:1					
Description	0:1					
Scope	1	Product / matrix	0:1	Product/matrix name	1	
				Product/matrix description	0:1	
				Product/matrix unit	1	
				Method of production	0:N	
				Packaging	0:N	
				Product treatment	0:N	
				Country of origin	0:1	
				Area of origin	0:1	
				Fisheries area	0:1	
				Date of production	0:1	
		date of expiry	0:1			
		Hazard	0:1	Hazard type	1	
				Hazard name	1	
				Hazard description	0:1	
				Hazard unit	1	
				Adverse effect	0:1	
				Source of contamination	0:1	
				Benchmark Dose (BMD)	0:1	
				Maximum Residue Limit (MRL)	0:1	
				No Observed Adverse Effect Level (NOAEL)	0:1	
				Lowest Observed Adverse Effect Level (LOAEL)	0:1	
		Acceptable Operator Exposure Level (AOEL)	0:1			
		Acute Reference Dose (ARfD)	0:1			
		Acceptable Daily Intake (ADI)	0:1			
		Hazard ind/sum	0:1			
Population Group	0:1	Population name	1			
		Target population	0:1			
		Population Span (years)	0:N			
		Population description	0:N			
		Population age	0:N			
		Population gender	0:1			
		BMI	0:N			
		Special diet groups	0:N			
		Pattern consumption	0:N			
		Region	0:N			
Country	0:N					
Risk and population factors	0:N					
Season	0:N					
General comment	0:1					
Temporal information	0:1	Time	1:N			
Spatial information	0:1	Region	0:N			
		Country	0:N			

Data background	0:1	Study	1	Study Identifier	1
				Study Title	1
				Study Description	0:1
				Study Design Type	0:1
				Study Assay Measurement Type	0:1
				Study Assay Technology Type	0:1
				Study Assay Technology Platform	0:1
				Accreditation procedure for the assay technology	0:1
				Study Protocol Name	0:1
				Study Protocol Type	0:1
				Study Protocol Description	0:1
				Study Protocol URI	0:1
				Study Protocol Version	0:1
				Study Protocol Parameters Name	0:1
				Study Protocol Components Name	0:1
		Study Protocol Components Type	0:1		
		Study Sample	0:1	Sample Name (ID)	1
				Protocol of sample collection	1
				Sampling strategy	0:1
				Type of sampling program	0:1
				Sampling method	0:1
				Sampling plan	1
				Sampling weight	1
				Sampling size	1
				Lot size unit	0:1
Sampling point	0:1				
Dietary assessment method	0:1	Methodological tool to collect data	1		
		Number of non-consecutive one-day	1		
		Dietary software tool	0:1		
		Number of food items	1:N		
		Type of records	1:N		
Laboratory	0:1	Food descriptors	1:N		
		Laboratory accreditation	1:N		
		Laboratory Name	0:1		
		Laboratory country	0:1		
		Assay Name	1		
Assay	0:1	Assay description	0:1		
		Percentage of moisture	0:1		
		Percentage of fat	0:1		
		Limit of detection	0:1		
		Limit of quantification	0:1		
Parameter / Factor / Input / Output / "Data column"	1:N	Left-censored data	0:1		
		Range of contamination	0:1		
		Uncertainty value	0:1		
		Parameter ID	1		
		Parameter classification	1		
		Parameter name	1		
		Parameter description	0:1		
		Parameter type	0:1		
		Parameter unit	1		
		Parameter unit category	1		
		Parameter data type	1		
		Parameter source	0:1		
		Parameter subject	0:1		
		Parameter distribution	0:1		
		Parameter value	0:1		
Parameter Reference	0:1				
Parameter variability subject	0:1				
Range of applicability of the model	0:1				
Parameter error	0:1				
Quality measures	0:N	SSE / MSE / RMSE / Rsquared / AIC / BIC	0:N		
		Sensitivity analysis	0:N		
Model equation	0:N	Model equation name	1		
		Model equation class/distribution	0:1		
Fitting procedure	0:1	Model equation reference	0:N		
		Model equation / Script	1		
Exposure	0:1	Hypothesis of the model	1		
		methodological treatment of left-censored data	0:1		
Events	0:N	Level of contamination after left-censored data treatment	0:1		
		Type of exposure	0:1		
		Scenario	0:1		
		Uncertainty estimation	0:1		

<https://docs.google.com/spreadsheets/d/1JN296AnRzi1XOKSer40Tdah2rCniOh2e-7veJojxrmw/edit#gid=1855550151>

“Standard” for Model Knowledge Representation Food Safety Knowledge Markup Language



Food Safety Knowledge Markup Language (FSK-ML)

Software Developer Guide

Version 0.9

Matthias Filter (Chair)	Federal Institute for Risk Assessment, Germany
Sascha Bulik	Federal Institute for Risk Assessment, Germany
Carolina Plaza-Rodriguez	Federal Institute for Risk Assessment, Germany
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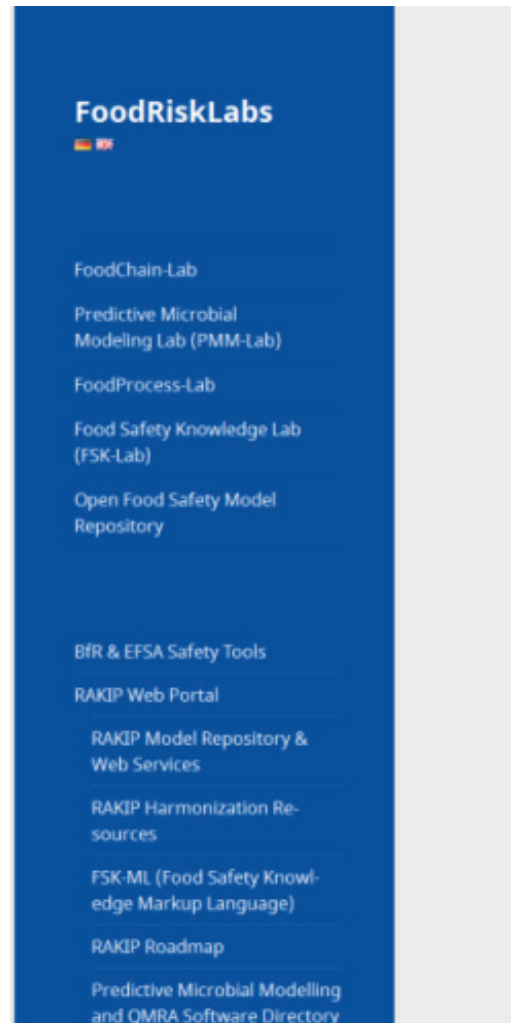
Alumni contributors:

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RAKIP Web Portal



RAKIP Web Portal



The food safety community is generating a variety of scientific knowledge (e.g. scientific publications, experimental data and mathematical models) and resources (databases and software tools for model generation and application). However, the access to this knowledge and the exchange of information between databases and software tools are currently difficult and time consuming. Therefore, three European institutions specialized in food safety risk assessment (ANSES, BfR and DTU Food) initiated a joint project to establish new community resources facilitating the efficient knowledge integration and exchange into and between IT-based applications and resources. The envisaged "Risk Assessment Modelling and Knowledge Integration Platforms" (RAKIP) will be based on harmonized data formats and consistent rules for knowledge annotation. The feasibility of this concept will be exemplified through an RAKIP Web Portal allowing users to access and download risk assessment models, modules thereof and related data in a harmonized file format. These files can then be imported and executed by software tools supporting the proposed harmonized file format. The RAKIP Web Portal therefore also contains supporting resources needed for the harmonized

RAKIP Model Repository Demonstrator (alpha)

KNIME WebPortal

1_ _RAKIP_Model_Repository_Demonstrator 2017-09-26 11:50:56

RAKIP Model Repository & Web Services

About Online Creation of Harmonized Models Upload of Harmonized Model

RAKIP Model Repository Demonstrator

Search Organism Environment Software Reset Selection

Model name	Model ID	Organism	Environment	Software	Details
Duarte_Fitting Distribution To Microbial Counts	Duarte_R		lab experiment	R	Details
ESBL Ecoli in Broiler	horizontal_transmi_animals_R	Escherichia coli o157:h7	Broiler	R	Details
ESBL Ecoli in Broiler	initialize_parents_animals_R	Escherichia coli o157:h7	Broiler	R	Details
ESBL Ecoli in Broiler	vertical_transmi_flocks_R	Escherichia coli o157:h7	Broiler	R	Details
ESBL Ecoli in Broiler	horizontal_transmi_flocks_R	Escherichia coli o157:h7	Broiler	R	Details
ESBL Ecoli in Broiler	initialize_parents_flocks_R	Escherichia coli o157:h7	Broiler	R	Details
ESBL Ecoli in Broiler	vertical_transmi_animals_R	Escherichia coli o157:h7	Broiler	R	Details
QMRA models on Salmonella in eggs	salmonella_egg_R		egg	R	Details
Secondary cardinal parameter model for umax of Listeria monocytogenes growing in chilled seafood and meat products model	Lmonocytogenes_Dalgaard_cardinal_parameter_model_R		chilled seafood and meat products model	R	Details
Aeromonas hydrophila modified BHI Growth Model Devieghere et al. 2000 Grooin database	Grooin database Row18	Aeromonas hydrophila	modified BHI	PKMlab	Details

Search for the available models

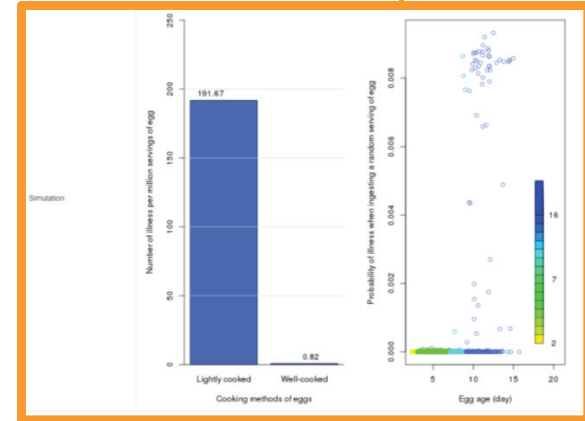
Select models

Run the models

Check the details of a specific model

Model Details

Feature	Value
Model name	ESBL Ecoli in Broiler
Model id	horizontal_transmi_flocks_R
Organism	Escherichia coli o157:h7
Environment	Broiler
Model creator	Carolina Plaza-Rodríguez, Guido Correa Carreira
Software	R
Model reference description	C. Plaza-Rodríguez, H. Sharp, U. Roesler, A. Friese, A. Kaesbohrer (2015). Development of a model for the spread of ESBL_AmpC E. coli in broiler production. Poster presented at the National Symposium on zoonosis Research, Berlin, Germany
Created date	11.18.2015
Modified date	06.09.2016
Rights	Public
Notes	This module calculates how the prevalence among flocks changes due to horizontal transmission of ESBL E. Coli between flocks on a given stage (hatchery, transports or broiler farms) of the modeled production chain. The impact of horizontal transmission on the prevalence among flocks is modeled by a generalized linear model.



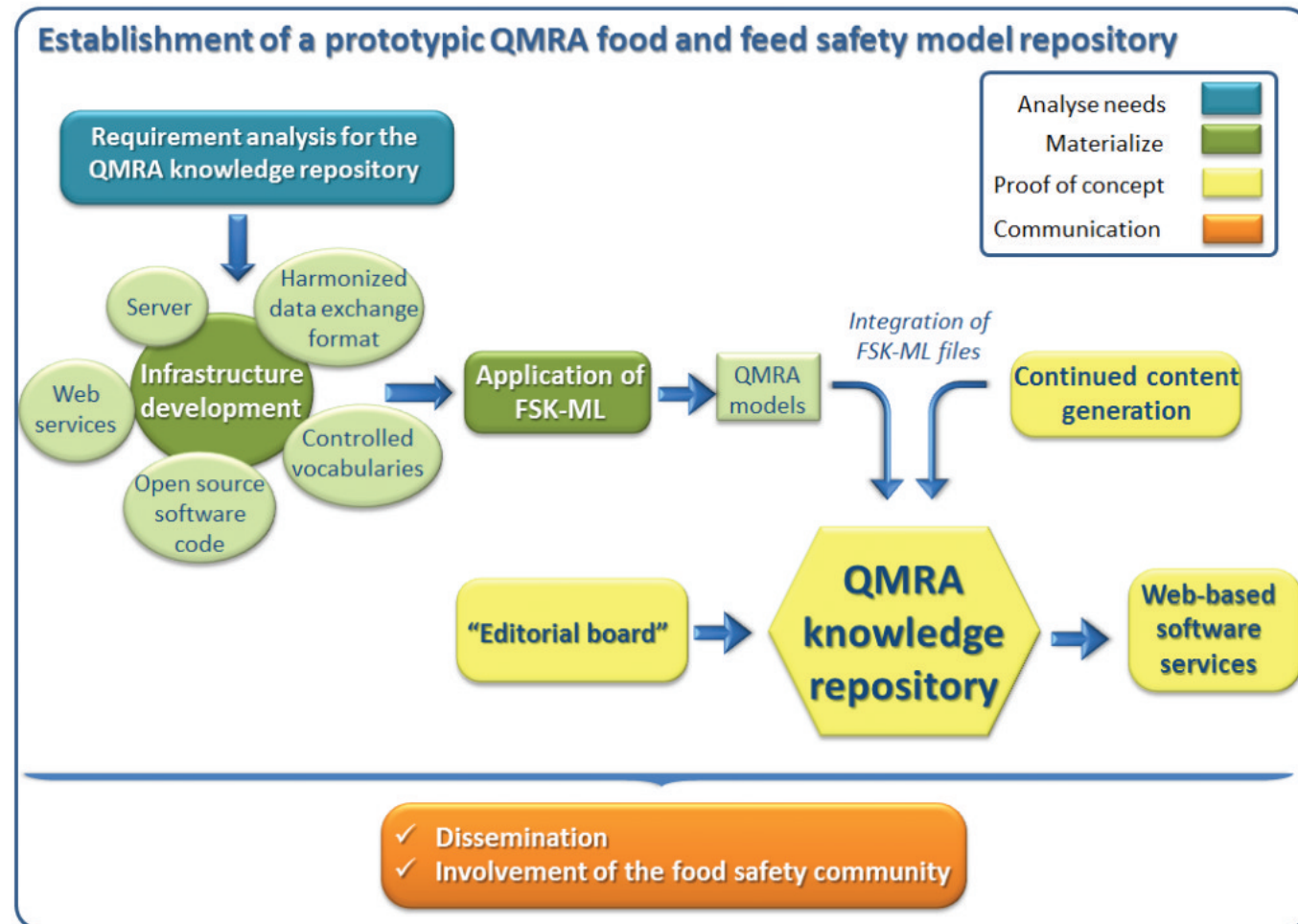
RAKIP – Still a way to go!



- Develop and maintain “operational” web-based infrastructures for knowledge exchange
- Extend and maintain harmonized terms and concepts
- Continuously improve standards / formats for knowledge representation
- Open source software libraries and converter tools to bridge to existing tools / databases / resources
- Promote adoption, create broad support and compliance

Future Solutions

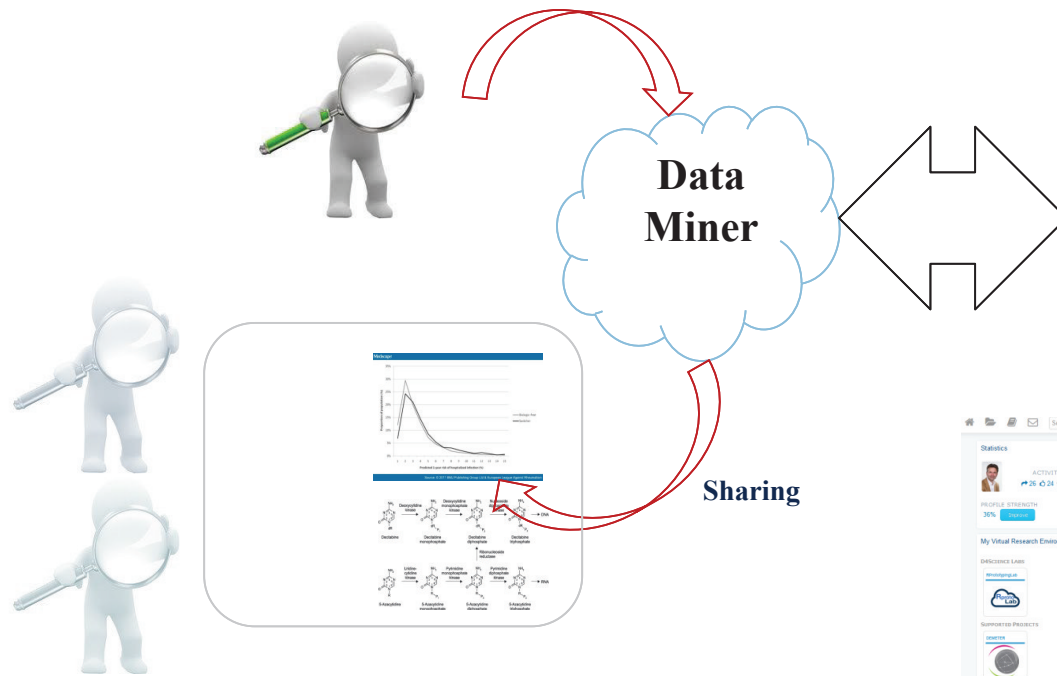
EFSA- BfR Framework Partnership Agreement



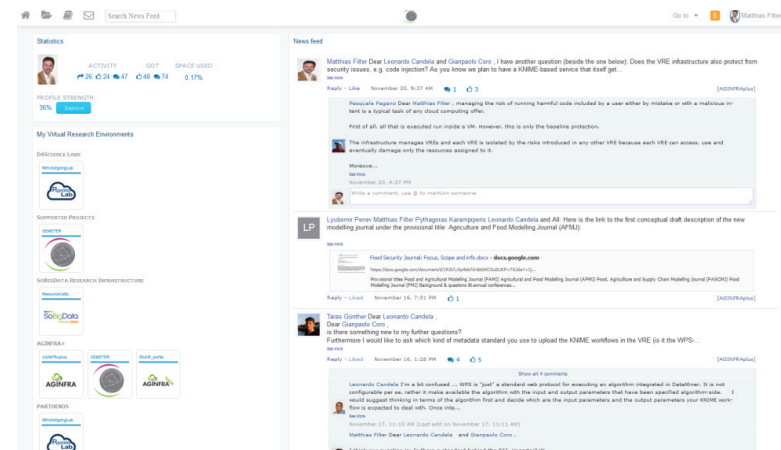
Future Solutions RAKIP Virtual Research Environment (VRE)



Setup and execution



D4Science
Computational
Facilities



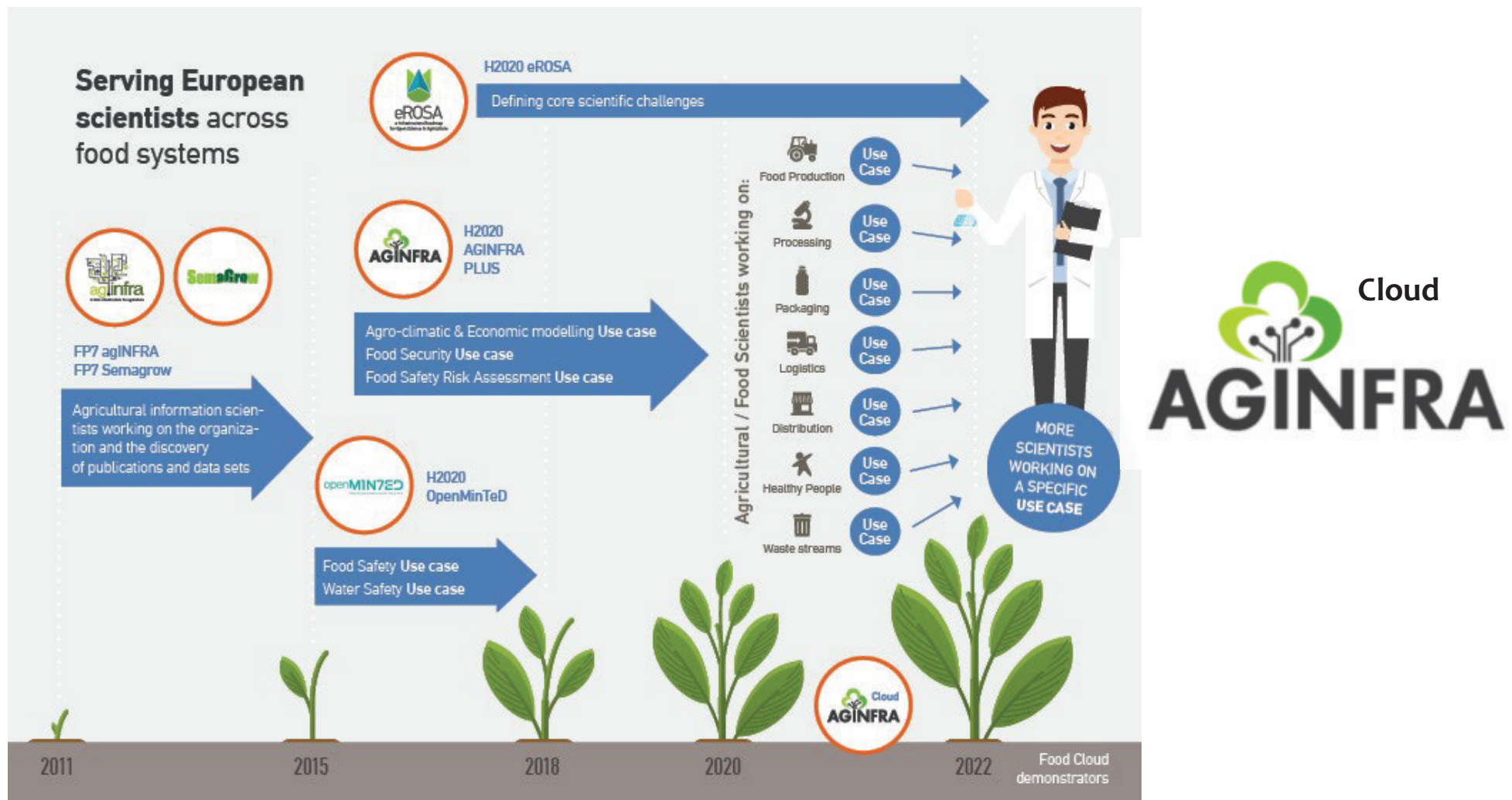
RAKIP Work Plan 2018

Exploration of new areas of application

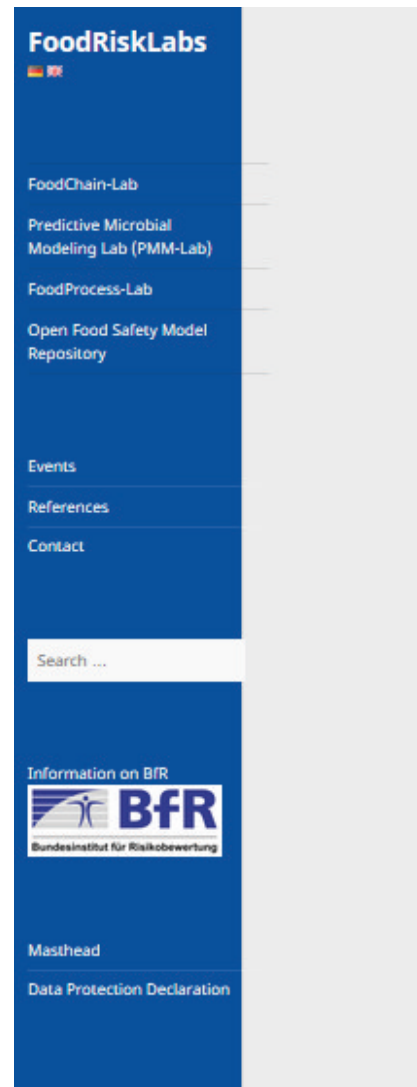
1. Broaden the **knowledge base** in the RAKIP Model Repository
2. Adapt and apply the RAKIP concept in **other areas** like chemical risk assessment (CRA), uncertainty analysis, antimicrobial resistance
3. Extend and improve required **infrastructure** facilitating efficient knowledge exchange (data standards, controlled vocabularies/ meta data schema and open source software code, bridges to popular 3rd party tools)
4. Disseminate and **propagate** the use of RAKIP resources through publications, workshops, software trainings and new collaborations
5. Establish an international **RAKIP Initiative** to promote the long-term maintenance and update of RAKIP resources...

Mid Term Planning

RAKIP as Part of the European Open Science Cloud (EOSC)



Finally



FoodRisk-Labs



FoodRisk-Labs is a portal

to the following tools

developed by the Federal Institute for Risk Assessment (BfR):



Tracing food back and forward along food supply chains



Modelling bacterial growth or bacterial and toxin inactivation



Representation of food process chains and modelling bacterial tenacity



Tools for predictive modelling in foods



Repository for predictive microbial models



OpenML for predictive modelling in foods

<https://foodrisklabs.bfr.bund.de>

Acknowledgement

RAKIP Co-Initiators:

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Virginie Desvignes (ANSES)
Ahmad Swaid (BfR)

Funding bodies:

ANSES, DTU, BfR

BfR:

IT + HR + Finance + Biological Safety departments, research coordination and international affairs units

Collaboration partners:

EFSA, FDA, Uni Cordoba, AGROKNOW, CNR, KNIME ...



Thank you for your attention

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