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MOOD

Monitoring Outbreak events for Disease surveillance in a data science context

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Project Information	
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Topic of the call	SC1-BHC-13-2019 Mining big data for early detection of infectious disease threats driven by climate change and other factors
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Project coordinator (Name of institution)	CIRAD
Cirad Project scientific leader (name, RU, e-mail)	Elena ARSEVSKA, ASTRE, elena.arsevska@cirad.fr
Project goals	MOOD aims at using state of the art data mining and data analytical techniques of disease data, Big data, and contextual data originating from multiple sources to improve detection, monitoring, and assessment of emerging infectious diseases (EID) in Europe. MOOD will establish a platform for mapping and assessment of epidemiological and genetic data in combination with environmental and socio-economic covariates in an integrated inter-sectorial, interdisciplinary, One health approach. More precisely, MOOD will develop: 1. The epidemic Intelligence community of practice to identify user needs of end-users i.e. national and international human and veterinary public health organizations; 2. Data mining methods for collecting and combining heterogeneous Big data; 3. A network of disease experts to define drivers of disease emergence; 4. Data analysis methods applied to the Big data to model disease emergence and spread; 5. Ready-to-use online platform tailored to the needs of the-end users and complimented with capacity building and network of disease experts to facilitate risk assessment of detected signals. MOOD outputs will be co-constructed with end-users at public health agencies to assure their routine use during and beyond project duration. They will be tested and fine-tuned on a set of air-borne, vector-borne, multiple-transmission route diseases, including anti-microbial resistance and disease X. Extensive interactions with end-users, studies into the barriers to data sharing, dissemination and training activities and monitoring of the impacts and innovations of MOOD outputs will support future sustainable use.
Key words	Infectious diseases, big data, epidemic intelligence, one health, impact, environmental changes, climate changes, user needs, socio-technical innovation
Project partners (Name of institutions)	CIRAD, ITM, FEM, ETH, INESC ID, ERGO, SIB, INSERM, ULB, KU LEUVEN, UM, SOTON, AVIA-GIS, MUNDIALIS, IRSTEA, OPENGEOHUB, UOXF, ISS, THL, GERDAL, IPHS, ISCIII, ANSES, INRA, ISID

Executive Summary

This report describes the innovation process and sets up the methodology to monitor the impact of the MOOD project through the outcome assessment and the theory of change.

The report is organized in three chapters. The first chapter provides background information on the H2020 call and the genesis of the project. The second chapter introduces the concept of impact pathway assessment and the way MOOD has been using this approach to define and review the overall project logic. Also, the second chapter presents the foundations of the innovation strategy and the way it is operationalized through the MOOD study cases and the disease models. The third chapter presents the project monitoring and evaluation system (M&E). It includes the key questions, indicators and tools and approach of the M&E.

Keywords

Impact, indicators, project outputs, outcomes

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References

ABBREVIATIONS

AH	Animal Health
AI	Avian Influenza
AMR	Anti-microbial resistance
ANSES	Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail, France
ASAP	As soon as possible
BRLa	Balanced readiness level assessment
CIRAD	Centre International de Recherche Agronomique pour le Dévelopement
EARS-NET	European Antimicrobial Resistance Surveillance Network
EB	Executive Board
EC	European Commission
ECDC	European Center for Disease Prevention and Control, Sweden
EDEN	Emerging Diseases in a changing European eNvironment (project)
EDENnext	Biology and control of vector-borne infections (project)
EFSA	European Food Safety Authority
EI	Epidemic Intelligence
ERGO	Environmental Research Group Oxford
ETH	Eidgenoessische Technische Hochschule Zurich
EU	European Union
FEM/FBK	Fondazione Edmund Mach/ Fondazione Bruno Kessler
GAM	Generalized Additive Model
GERDAL	Groupe d'Expérimentation et de Recherche : Développement et Actions Localisées
INRAE	Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement
INSERM	The Institut national de la santé et de la recherche médicale is the French National Institute of Health and Medical Research.
IP	Impact Pathway
ITM	Institute of Tropical Medicine Antwerp
KPI	Key Performance Indicator
LASSO	Least Absolute Shrinkage and Selection Operator (statistical method)
M&E	Monitoring and Evaluation
MOOD	Monitoring Outbreak events for Disease surveillance in a data science context project
NA	Non applicable
OGH	OpenGeoHub foundation
OIE	Office International des Epizooties: World Organization for Animal Health
PCDM	Progress and completion of deliverables and milestones
PH	Public Health
PhD	Doctor of Philosophy
SDM	Suitability disease modelling (academic degree/ student)
SIB	Swiss Institute of BioInformatics
TBE	Tick-Borne Encephalitis
THL	Finnish Institute for Health and Welfare, Finland (Terveyden ja hyvinvoinnin laitos)

TRL	Technology Readiness Level
ULB	Université Libre de Bruxelles
UOXF	Environmental Research group Oxford
URL	Uniform Resource Locator
VBD	Vector borne diseases
VH	Veterinary health -> Animal Health (AH)
WHO	World Health Organization
WNV	West Nile Virus
WP	Work Package
WS	Workshop

1. Introduction

1.1 Call H2020

In 2019, as part of the Horizon 2020 Framework Program, the European Commission launched the call “Better Health and care, economic growth and sustainable health systems (H2020-SC1-BHC-2018-2020)” with one of the specific topics on “Mining big data for early detection of infectious disease threats driven by climate change and other factors (SC1-BHC-13-2019)”. This call has set up the scene of the co-construction work among researchers and end-users in the epidemic intelligence (EI) sector. WHO defines epidemiological intelligence as "the systematic collection, analysis and communication of information for the detection, verification, assessment and investigation of health events and risks with the aim of early warning ". According to Barboza[1], epidemiological intelligence integrates information from event monitoring and indicator monitoring data (e.g. data from other early warning systems, surveillance systems) and is not intended for long-term monitoring of trends or morbidity. Regarding this very-specific aspect, the call stated:

"/The ready-to-use analytical tools and services that are developed should be based on an assessment of the needs of potential end-users in the Member States and on European level, should as far as possible build on and be compatible with existing European initiatives, and should remain available for public use at the end of the project at a reasonable cost./"

"/The successful proposal(s) should foresee to consult with the end-users at both national (e.g. public health institutes) and European (e.g. ECDC, EFSA) level at key milestones of the project's timeline/".

Acknowledging the complexity of data collection and communication between the stakeholders of EI (large set of different institutions and sectors with different norms and priorities), the call requested for an innovation strategy that would not be only based on a technical-driven approach. End-user capacities, institutional imperatives and organisational schemes have also to be addressed. Even though, these multi-dimensional barriers to innovation are poorly known[2,3].

The MOOD project responded to this call by proposing a global and integrative user-driven approach (based on participation) allowing a better appropriation of project outputs by end-users, and ultimately, a positive impact on public health.

1.2 Genesis of MOOD

Origins of MOOD

Several MOOD partners that contributed in the design of the project have a long and productive collaboration history. In particular, two previous European projects – EDEN (Emerging Diseases in a changing European eNvironment) and EDENext (Biology and control of vector-borne infections) – have seen researchers from these partner institutions working together to produce new knowledge in the field of epidemiology of vectors and vector-borne diseases

[1] Barboza P. Evaluation des systèmes d’intelligence épidémiologique appliqués à la détection précoce des maladies infectieuses au niveau mondial. Santé publique et épidémiologie. Université Pierre et Marie Curie - Paris VI, 2014. Français. NNT : 2014PA066529 . tel-01133801

[2] Bordier M. et al, 2018. Preventive Veterinary Medicine. http://doi.org/10.1016/J.PREVETMED.2018.10.005

[3] Ribeiro C.S. et al, 2018. PloS One, 13(5).

(VBD), to train a cohort of students that have then pursued their carrier in public health (PH) agencies and to produce new databases about vectors and vector distribution in Europe.
The development of information systems by MOOD (see https://www.moodspatialdata.com/) and the existing expert networks such as VectorNext (https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/vector-net), to which many MOOD partners belong, have been possible thanks to these previous projects (Eden, Eden next) and previous networks (Vborne, VborneNet, VectorNet) with the constitution of databases on the presence of the main vectors of human and animal pathogens (databases managed by ECDC and EFSA). These databases continue to be used by national health agencies and researchers for the production of vector distribution maps, but also for modelling vector population dynamics and pathogen transmission.
These two projects also helped in building strong relationships between the current MOOD partners, their professional networks, the European Centre for Disease Prevention and Control (ECDC), as well as with national Public Health and Veterinary Health agencies staff (as researchers or trained staff), and the European Food Safety Authority (EFSA).

Originality of MOOD

While building on the previous collaboration and projects, the design of MOOD represented a change of paradigm for the organisations and researchers who worked in EDEN and EDENext. The challenge to be addressed through the new project was larger than the one previously tackled and included more prominently the development of capacities in PH/AH agencies, though the better use of existing data, increased capacities to analyse big data and new tools that ease the inter-sectoral collaborations (this is a core objective from the current project EpiCap). The change of paradigm of MOOD also concerns the strong impact orientation and the implementation of an outcome assessment done by a multidisciplinary team involving epidemiologists and sociologists.
MOOD project aims at strengthening international and national PH/AH institutions in case-study countries to be better informed and prepared about potential disease drivers and impacts of climate change on disease emergence, and to assess risks more effectively. In the medium term, these changes in knowledge and practices will contribute to a more efficient response to infectious disease threats, more adapted prevention, surveillance and control strategies, policies and measures at national and international levels, and improve health practitioners' interventions and citizens' behaviour for the prevention of infectious diseases. In the longer term, those changes will contribute to improve EU preparedness to emerging infectious disease threats, and improve human and animal health and welfare.
The strategy proposed to contribute to these objectives is based on the participation of the stakeholders (researchers and EI practitioners) in the impact-oriented project management and the co-conception, together with the end-users, of innovative tools and services for the early detection, assessment, and monitoring of current and potential infectious disease threats in Europe. Also, innovations developed will consider and address the challenges of cross-sectoral data sharing and common analysis in a One Health framework based on cross-sectoral collaboration for animal, human and environmental health.
The general planned workflow of MOOD (Figure 1) was initially based on the needed data-flow from WP2 in charge of identifying and collecting health and covariates data, to the data processing (WP3-standardization and integration), then the modelling and analysis of big data (WP4) up to the development of tools (WP5). WP1 aims to analyse the user needs and facilitates the user validation and feedback across the different steps of design of the MOOD tools and services for epidemic intelligence. WP6 is in charge of capacities strengthening of the users and dissemination of the tools.

This workflow contains feedback loops of user validation. On top of these loops, non-linear interactions take place during the co-conception process: the discussion to further define the useful specifications can be led, in the framework of the learning loops by the partners of WP2, WP3, WP4, or WP5 while WP1 and WP6 bring a support to the thinking process.
ECDC has been early (by the call) identified as one of the main users of the MOOD innovations as they implement the Epidemic Intelligence externalized by many European countries to them, and they have also the role of guidance and strengthening of capacities of the European Member States. In addition, due to the emerging COVID-19 pandemic and its first wave in March 2020 (early at project start), the European Commission (EC) requested the MOOD coordination to reorient in the amount of possible the project activities in the framework of the COVID-19 response and in close collaboration with ECDC and European national PH agencies.

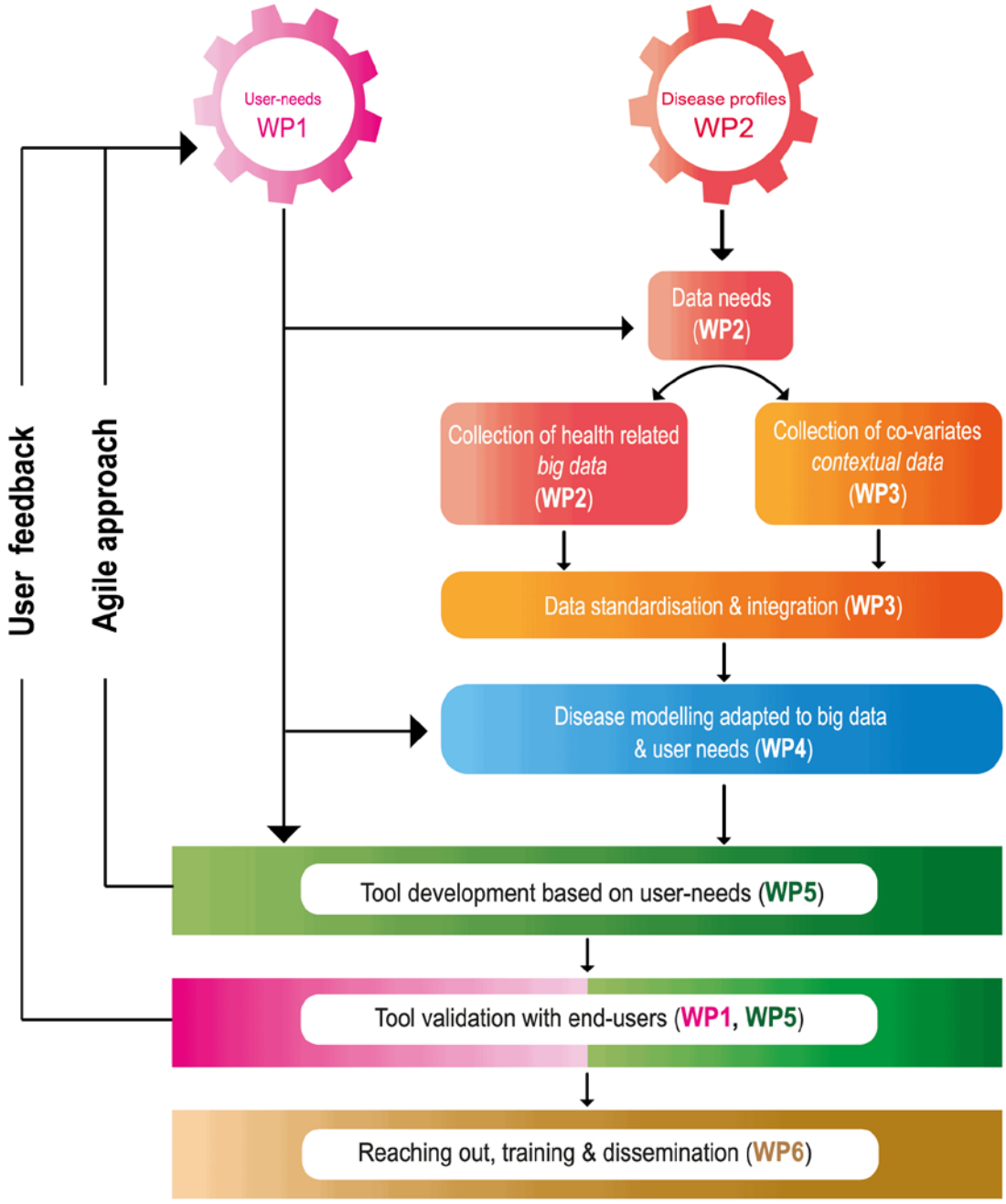

Figure 1. General workflow of the MOOD consortium

2. Participatory impact pathways and innovation strategy

2.1 Impress ex-ante: a participatory approach for building impact pathways

Impress ex-ante is a strategic planning and implementation approach developed by CIRAD[4]. It allows, through a participatory process, for:

1) Building and elucidating the logic of the intervention, its structure and plausibility via the development of a shared vision and understanding among stakeholders about changes and conditions needed to achieve the planned goals;
2) Reflecting on and defining the strategies that the intervention can adopt to achieve its objectives and contribute to long-term changes (beyond the project framework and time-frame);
3) Facilitating the design of an "outcome-oriented" monitoring and evaluation system that can support adaptive management, learning and reflexivity.

The participatory development of impact pathways is central in the ImpresS ex-ante approach. It is used to visualize "the logic of the intervention and to reflect on the causal relationships between the inputs mobilized, the outputs produced by the intervention, the desirable changes (outcomes) that the intervention aims to generate as a result of the appropriation of these outputs by different actors, and the societal and environmental impacts to which these outcomes contribute" [5].

The participatory process used to develop the impact pathway is considered in itself a key result of the approach. In fact, by facilitating the interactions and exchanges among stakeholders about the vision of the future, the desirable changes, the role of different stakeholders and the specific contributions of the project, the process builds a stronger shared understanding of the intervention and of the role and contribution of each partner.

Another important specificity of the ImpresS ex ante approach is that it is actor-centred, "i.e. it focuses on changes in practices, behaviours and interactions for specific actors that the intervention aims to generate through the appropriation (use, adaptation, transformation) of its outputs" [6]. The focus on the actors helps in assessing potential obstacles and opportunities in terms of knowledge, capacities and motivations required for desirable changes to happen and then helps in critically assessing the planned outputs (and their potential use, adaptation, transformation) and in defining appropriate intervention strategies that can be implemented by the project.

The participatory development of the impact pathway is ideally realized during the design phase of an intervention. Nevertheless, the approach is adaptive and can be mobilized at different stages of the intervention. Also, the review of the impact pathway can be part of the "outcome-oriented monitoring and evaluation system" and can be used as collective opportunity to periodically reflect on the overall logic of the intervention. This periodic review may allow to either confirm the validity of the impact pathway after a period of project implementation or to

[4] Blundo Canto G. et de Romemont A., Hainzelin E., Faure G., Monier C., Triomphe B., Barret D., Vall E. (illus), 2020. ImpresS ex ante : démarche pour co-construire ex ante les chemins d'impact de la recherche pour le développement. Guide méthodologique ImpresS ex ante deuxième version. Montpellier, France; Cirad, 74 p. ISBN : 978-2-87614-759-1 EAN: 9782876147591. https://doi.org/10.19182/agritrop/00142.

[5] *idem* ImpresS ex ante : démarche pour co-construire ex ante les chemins d'impact de la recherche pour le développement.

[6] *idem* ImpresS ex ante : démarche pour co-construire ex ante les chemins d'impact de la recherche pour le développement.

identify positive and negative elements that have been overlooked or that have emerged and decide how and where the project strategies and activities have to be adapted.

2.1.1 MOOD experience with impact pathway development and review

The expected impact of the MOOD project as well as the overall logic of the intervention were co-designed, during the writing proposal phase, with a limited number of representatives of the current MOOD partners and practitioners of EI seen as potential end-users (PH/AH agencies partners of the project) using the ImpresS ex-ante approach.
The participatory sessions held during the writing proposal phase facilitated the identification and formulation of the expected outcomes i.e. the changes in knowledge, attitudes, skills, practices and interactions of targeted stakeholders that MOOD may reasonably expect to generate by its end (short to medium term). Thanks to these sessions, the medium to long term vision of the impact the project wants to contribute to was set out.
The initial impact pathway (Figure 2) provides a visual presentation of the main deliverables expected from each work package, the linkages among these deliverables, the four main expected outcomes and their alignment with the long-term impacts identified by the EU through the call **SC1-BHC-13-2019 (Box 1)**.
A workshop to share the impact pathway with a larger group of stakeholders was planned at the beginning of the project but had to be postponed due to the COVID-19 related restrictions and lockdown in March 2020. Such a workshop should have ideally included the representatives of all partners, representatives of influential actors, and the impacted actors who are targeted by the intervention (i.e. end users). The workshop would have allowed for a critical review and a broader validation of the intervention logic.

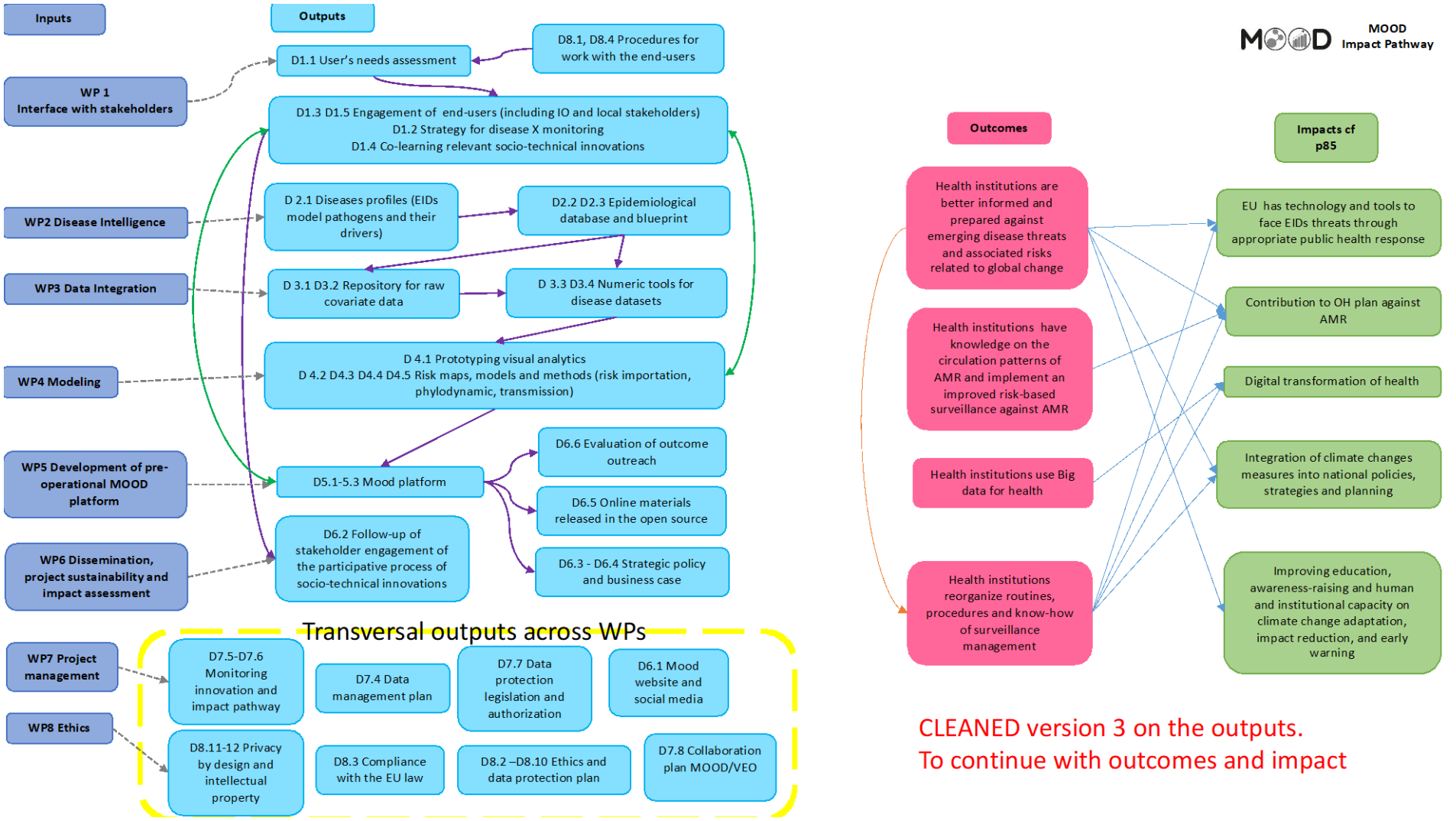

Figure 2. First diagram of the impact pathway of the MOOD project

In the MOOD proposal, regular impact pathway (IP) reviews have been preconized as part of the project monitoring, evaluation and learning system. These reviews aim at enabling strategic management, by identifying the needed adjustments and adaptations to the initial pathway, and by understanding the outcome generating processes. Following these reviews, outcomes and related indicators could be updated and finetuned as well as strategies to contribute to their achievement could be refined or adjusted. IP participatory reviews have also been identified as a risk-mitigation action to prevent a diminished stakeholder engagement in the MOOD impact-oriented strategy (see MOOD Critical Implementation risks and mitigation actions).
The reviews are placed under the responsibility of the Project management unit (WP7 - Coordination and project management). Nevertheless, when the preparation of the first IP review started in January 2021, the need for a close collaboration with other WP teams was quickly evident. In particular, the closest links were identified with the WP1 team (WP1 - Interface with stakeholders for innovation) that, amongst other activities, is in charge of users' needs assessment, developing guidelines for stakeholder engagement in the co-conception process and facilitating learning loops, and with the WP6 team (WP6 - Dissemination of information and impact assessment) that has responsibilities in monitoring project outreach and assessing outcome impact.
Staff from WP7, WP1 and WP6 together with two members of the ImpresS team were actively involved in the facilitation of the IP review process. Given the standing sanitary regulations related with COVID-19 pandemic at the beginning of 2021, organizing participatory face-to-face workshops was not a viable option. The sanitary situation, the existence of the initial pathway and the time constraints under which all the project staff were working, were the main reasons not to organize a broad participatory workshop to review the initial impact pathway with all the stakeholders.

Details can be found on the link https://app.klaxoon.com/participate/board/NJAX4CV)

Instead, building on the initial impact pathway (Figure 1), on the project proposal (see *BOX 1. MOOD contributions to Impact areas*) and on the results of the users' needs assessment (https://mood-h2020.eu/d1-1-report-on-users-needs/), the facilitation group drafted a revised version of the IP (Figure 3 for the complete overview of the impact pathway and Annex 1 for a more readable version of the different branches. .

BOX 1. MOOD contribution to Impact areas

Strengthened EU preparedness to address (re-)emerging infectious disease threats, by making available the appropriate technology and tools to support an appropriate public health response.

MOOD tools and services are co-produced with end-users in line with their needs. They can be readily integrated into existing epidemic intelligence systems. We expect that by the end of MOOD, national and international human and veterinary public-health health institutions will renew their approach of risk through more integrated data and analysis suits that help them to reach their goals. These organisations will be more aware of other methodologies, know how to use prediction models and indicators of disease emergence based on different integrated data sources, and have a broader and transboundary overview of risks. Hence, they will be better informed and prepared about potential disease drivers, impacts of climate change on risks, and assess risks. These changes are expected to generate an impact by stimulating an integrated harmonized approach of risk among international organizations leading to a more efficient response to infectious disease threats and climate change impact reduction.

Contribution to the European One Health action plan against antimicrobial resistance.

MOOD will explore the role of international trade on the global dynamics of antimicrobial resistance (AMR) and assess the risk of importation in Europe. It will also assess the intra-European dynamics of AMR, leading to increased burden due to domestic circulation of pathogens, with potential introduction of new strains. These new insights will help to better understand patterns of circulation on which novel approaches can be designed to improve surveillance by targeting those areas and regions at risk of higher antimicrobial resistance concentration because of trade. It is expected that these insights will contribute to the European One Health action plan against antimicrobial resistance.

Contribution to the digital transformation of health and care within the context of the EU Digital Single Market.

MOOD opts for openness and contribution to the EU digital transformation of health and care. MOOD intends to provide databases and the developed innovations as open source, where possible. The preferred licensing scheme is the Massachusetts Institute of Technology license, which permits any re-use including for closed, commercial applications. The code and the data will be made available through a public repository. Further, the integrated data sets will be made available within the framework of the European General Data Protection Regulation, described in WP6. These two elements are expected to enhance the use of Big data for health.

Contribution to achieving Sustainable Development Goal (SDG) 3 and specifically the targets on: 1) combating epidemics, and 2) strengthening capacity for early warning and response to health risks. Contribution to achieving of SDG 13 and specifically the targets on 1) integrating climate change measures into national policies, strategies and planning, and 2) improving education, awareness-raising and human and institutional capacity on climate change adaptation, impact reduction and early warning.

The innovations of MOOD will contribute to "combating epidemics" and "strengthening capacity for early warning and response to health risks" by providing the tools and services to early detect monitor and assess infectious disease threats. MOOD will also set the steps to broaden the value of the product outputs to a generic disease. Europe will be equipped for the first time with a streamline, integrated, and user driven epidemic intelligence system, based on customised and technically focused quantitative methodologies, and a broad base of diverse data sources. We expect PH/VH agencies in Europe will be better informed and prepared about potential impacts of climate change on risks, by better understanding the diversity of factors driving the disease emergence and enabling the routine, procedures and know-how of managing the surveillance. Through its capacity building activities and the learning loops with end-users, MOOD will strengthen institutional capacity and capacity of the scientific community to early warning and epidemic intelligence.

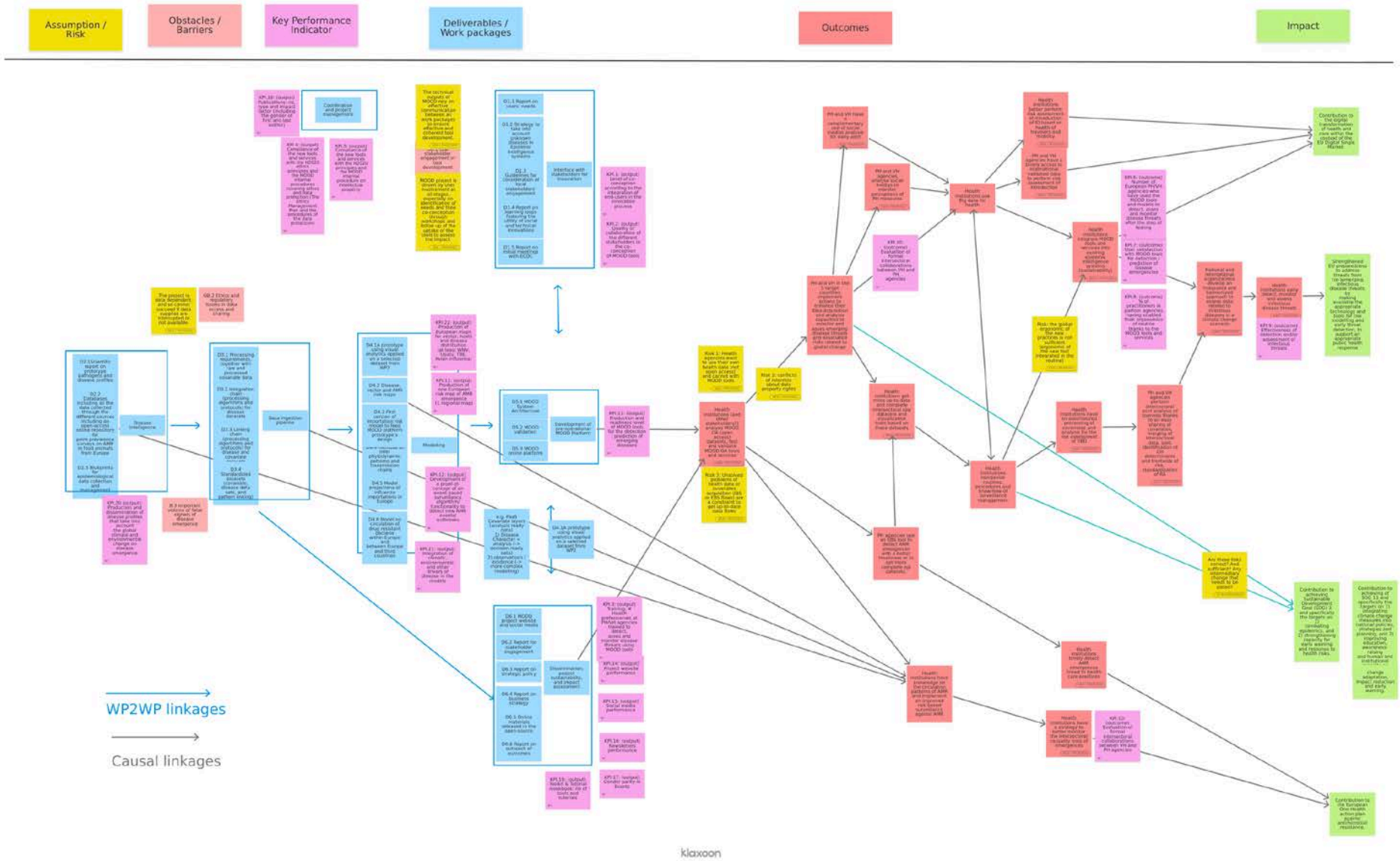

Figure 3. Revised diagram of the impact pathway (revised in June 2021 and new KPIs added in December 2021).

Details can be found on the link https://app.klaxoon.com/participate/board/NJAX4CV)

The main differences between the initial (Figure 2) and the revised IP (drawn 15 months (M15) after project launch; Figure 3 and annex 1 (Figures 7, 8, 9, 1à and 11) were:

- the linkages between the WPs and the transversal activities were highlighted;
- outcomes were reformulated and made more specific following the users' needs assessment;
- linkages among outcomes contributing to different pathways were drawn;
- expected linkages among project outputs and outcomes were drawn;
- risks and indicators (Key Performance Indicators, KPI) were reviewed and visualized in the IP.

The revised version of the IP was shared with WP leaders, task leaders and subtask leaders as a working document using a digital collaborative whiteboard (i.e. Klaxoon). One week after sharing the document, two working sessions were organized to collect reactions and suggestions in order to refine the draft before submission to the MOOD executive board for further review and validation. Sixteen MOOD researchers (cumulated) participated during the two working sessions. All the work packages but WP5 were represented.

Adopting a stepwise approach for opening-up the reflection around the IP to a growing number of participants was a deliberate choice made by the facilitation group given the conditions under which this first review process had to be realized. Participatory development and reflections around a shared vision of the intervention goals and the strategies to contribute to their achievement is a key principle of the Impress ex-ante approach. Adopting a stepwise approach may seem contradictory to this principle. Nevertheless, the facilitation group was aware that only some participants had participated in the development of the initial version of the IP and that most were not entirely familiar with the IP concepts and tools.

The review process (Figure 3) allowed for a structured reflection about the overall MOOD intervention logic and how it has been translated into actions during the first 15 months of the project.

The need for a highly integrated work across WPs was confirmed. It was highlighted that, compared to the current situation, a closer collaboration among teams working in different WPs will be required. The extreme importance of project and WP coordination was reaffirmed. Participants noted that IP showed linear linkages from WP2 to WP5. They confirmed that this global logic is correct and shows how starting from a better understanding and profiling of the diseases, the identification, accession, treatment and standardization of a variety of data from many sources, the project will be able to develop and finetune models and procedures for their analysis and the restitution of the results through several standardized tools and services (including dynamic maps). Nevertheless, it was also noted that not all the MOOD productions would follow this entire path. In fact, it has already been observed that, responding to users' demands, the project team is making available or co-developing with national agencies, a set of outputs (i.e. databases, ingestion procedures, maps) that are case-specific and that integrate national agencies workflows at different stages.

Participants in both meetings agreed on the overall validity of the IP diagram but asked for a more detailed discussion based on the definition of "use cases". A use case was defined as a set of integrated activities aiming at addressing challenges and or users' needs identified for a specific disease x country(ies) x user(s) combination. Participants thought this approach would be more effective in that it will allow for direct interactions between smaller groups of project team members, including representatives of national agencies, and it will give the opportunity to precise actual workflows and reflect about tangible uses of the expected outputs. Taking into consideration the diseases that have been already prioritized for the year 2 of the project, participants suggested to consider the following list to develop use cases: COVID, West Nile, Tick borne diseases, Avian influenza, Antimicrobial resistance (AMR). The role of WP1 team in facilitating the interactions among national agencies representatives and MOOD research

teams was restated as well as the importance of regular feedback and learning loops to ensure users' needs are being effectively addressed and needed adjustment in project strategies are being considered. Several meetings were needed to define precisely the roles of the WP1 team for the facilitation, as well the transversal role of WP5 and WP6.4 for the monitoring of the platform development and the assessment of the outcomes (Cf. p19).

2.2 Innovation strategy

The theoretical workflow of the conception of MOOD tools and services is grounded in the planned data-flow and the transversal interactions (from WP1 and WP6 in particular): methodological support for facilitation, support to organize, monitoring of the impact, technical monitoring, communication. Some iterative feedback loops have also been planned (Fig.1).
For users, it is necessary that the tools are:

1- Adapted to their needs (Box 2), i.e. that respond in an efficient and relevant way to the problems raised during the identification of the needs
2- Sustainable, which implies that they are operational and integrated into the reality of their activities and working conditions in a sustainable manner (with the possibility to produce updates etc.).

The ambition is therefore to articulate a scientific validity of the tools that will be produced and an effectiveness of their use in a given professional environment. For that purpose, a strategy of co-conception process has been based on a participatory assessment of the EI practitioners' needs followed by 2 years of development of tools called "learning loops" during which the needs are in-depth defined, the specifications of tools discussed with users, the prototypes are tested in real conditions and the useful strengthening of capacities identified.

BOX 2. Theoretical Framework for a participatory assessment of needs

What do user needs mean? These are expectations and areas for improvement that are expressed in relation to, or in response to, problems and concerns encountered in the professional activities of users. The starting point for the identification of needs is therefore the user's own analyses of their situations: what works well, the difficulties they encounter and what needs to be improved.

"the problems are not given by the situations but by those who experience them"(Darré, 2004).

These concerns are translated into issues to be addressed. It is not necessarily possible to formulate a direct need in relation to these problems, since the response is often multi-factorial.

The sociology developed by GERDAL postulates that innovation, which can either start with a change in practice or a change in design, refers to a process of knowledge generation that takes place in and through dialogue. First al all, this dialogue is between peers, who have common activities and shared professional reference system ("system of standards", of ways of working, which is nevertheless made up of variants), but also with their stakeholders who often have different points of view. These peer relationships can be more or less formalized within a network or group (e.g. a team in an institution, network of experts around a particular object). Faced with a problem to be solved, each one mobilises his/her dialogue network(s) in a specific way: the mobilized interlocutors and the scale of dialogue is specific to the type of problems. There are important variations in the forms and density of relationships, in the degree of structuring of dialogue networks, in other words, not everyone is placed in the same position with regard to access to cognitive and social resources to solve a problem.

Thus, we want not only to identify the "problems to be solved", but also to identify professional networks, including relationships between peers (as defined above) or with more distant stakeholders, at different scales, and to characterize these networks according to the different types of activities and their relationship to epidemiological data within epidemiological surveillance systems at the national level. Understanding the current problem-solving strategies of EI practitioners will make it possible to organize the support process and their active enrolment as well as to develop and inform a monitoring and evaluation system for the project.

Comprehensive socio-technical analysis

The analysis focuses on the characterization of the users, an overview of their digital practices and norms associated, an identification of their priority concerns, difficulties and current problems seen according to their point of view.
This need assessment relies on the collection of end users' view on their professional attributes, their digital practices, their professional network and the main **difficulties** they encounter. The participatory diagnosis of difficulties will be in-depth discussed to understand the causes and ways to solve these difficulties according to their "norms" of work. On this basis, we interviewed them in order to understand the situation in which they experience the complex **problems** that they wanted to solve. We collected the attributes (not pre-defined) of the socio-technical solutions they want, but the needs (what needs to be done, a sequence of multiple actions and solutions) cannot generally be expressed directly. Indeed, users are confronted with complex problems, the solutions of which, are not necessarily a single factor, and are not necessarily linked only to the development of a tool. The process for defining a clear definition of needs (i.e. the type of responses, the "means" to be implemented: tools, organization modalities, data quality, interactions between actors, etc.) is collectively discussed between users and consortium partners during workshops (WS).

Concern, difficulties → problems to solve → complex needs
Identified and prioritized by users *modifiable according to collective thinking* concertation process

The enrolment of stakeholders in a process of effective and collective change requires:

1. that these stakeholders find themselves in a situation where the problems to be addressed and the things to be improved are formulated. This presupposes that they can express their expectations (concerns and analysis of what needs to be improved), considering diversity, i.e. each according to their own point of view;
2. that their change strategy is appropriately supported, i.e. by placing at the heart of the process the modes of reasoning of the stakeholders (with a view to changing conceptions and practices, as indicated above) rather than proposing a path based on external expert reasoning.

It is to this ambition that the exchanges between researchers and users must respond. An initial participatory assessment of the user needs was achieved during the first year by a team of sociologists from WP1. The D1.1 allowed to understand the EI practices of PH/AH agencies concerned by a need of change/innovation, to identify the difficulties met and the problems experienced by the EI practitioners, and to start to identify the paths of solutions MOOD could propose. But the specifications of tools and services must be further defined by the study case groups through the 2 years of "learning loops" (co-conception).

The methodological approach for the user needs assessment relied on the comprehensive socio-technical analysis as explained in Box 2 The implementation of the approach to assess the user needs included five steps (Figure 4).

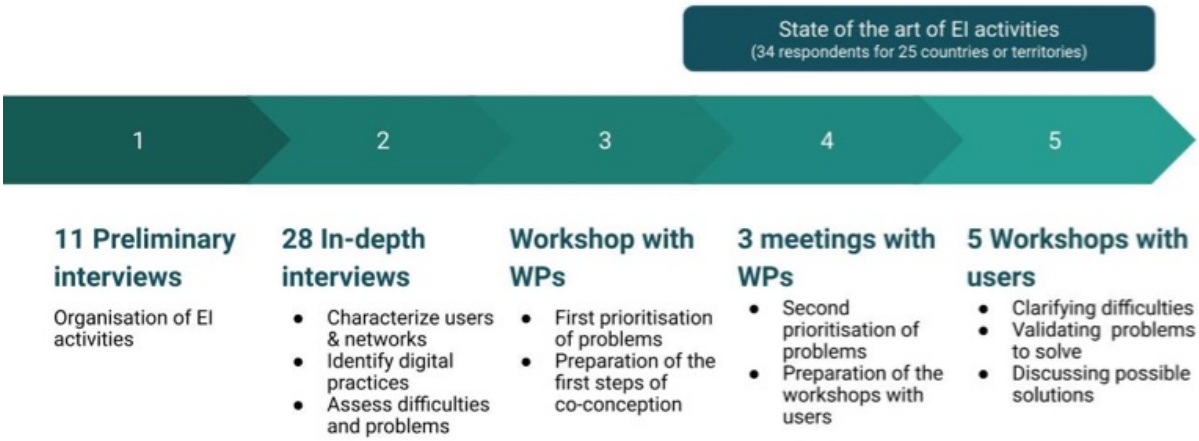

Figure 4. Timeline of the different steps of the user needs assessment in MOOD (task 1.2)

The five steps of the user needs assessment are detailed in the below:

1) Step 1 involved preliminary interviews with one key-informant by sector and by country from January to February 2020. These interviews were conducted by three epidemiologists involved in the MOOD consortium. The aim was to allow an understanding of the general organization of PH and AH EI activities, to identify criteria used to characterize these EI activities and the interviewees to enrol.
2) Step 2 comprised in-depth interviews, conducted by a team of sociologists and anthropologists from March to November 2020. A crossed socio-technical analysis of the interviews was carried out to characterize the stakeholders and their objectives. The interviews helped to describe their digital practices, their professional networks, and aimed to identify difficulties and problems experienced, including a characterization of useful data, tools and digital services. A synthetic table of difficulties, problems expressed by the users and points of discussion (points of vigilance or paths of solution mentioned by the users) was built in order to show the diversity and nature of problems.
3) Step 3 involved a presentation of the results of the socio-technical analysis to the MOOD consortium during a workshop (WS) in September. This WS aimed to prioritize the user problems, and to sort identified users' problems by accurate categories with regards to the relations to the EI data (i.e. related to data collection, data processing, or data analyses, etc.) and then by thematic topic. These meetings were useful for each WP to prepare the next discussion of proposed solutions, by discussing the feasibility of the potential paths of solutions.
4) The fourth step consisted of dedicated meetings among the different MOOD WPs to discuss, on the basis of the synthetic table of problems, which further information is needed to prioritize the questions for the users, thus to organize the first interaction with users. We grouped the identified problems in thematic clusters, corresponding to the priority themes to be addressed in the framework of MOOD. We chose the format of short and independent meetings with users in dedicated small groups by thematic topic. The participants were the users that expressed problems related to the topic, the users

interested by the topic and one or two researchers of each WP (those researchers most suited to discuss the feasibility of the paths of solution).

5) Step 5 involved five thematic WS that were organised in December 2020. Each WS was dedicated to specific priority issues of the users and the research activities planned to answer them, and aimed at clarifying the difficulties, validating the problems to solve and discussing potential solutions.

Learning loops

To organize efficient exchanges with the EI practitioners that will allow to define more precisely the needs and specifications related to the multiple dimensions of the final innovations, the consortium initiated five case studies around model diseases:

- Avian Influenza (started in 2020; facilitator: J. Artois, WP4, ULB)
- West Nile (started in 2021, facilitator: A. Rizzoli, WP2, FEM/FBK)
- Tick-borne encephalitis (started in 2021; facilitator: T. Dub, WP1, THL)
- Covid-19 (started in 2020, facilitator: C. Poletto, INSERM, WP4 & S. Delicour, WP4, ULB)
- Antimicrobial Resistance (started in 2021, facilitator: E. Van Kleef, WP1, ITM)

A working group of partners and EI practitioners (from the consortium and external) is set up for each case, with the support of one or two facilitators and an animation team. A small number of user needs will be selected by the partners and then validated by the users to be addressed in each case study. The involvement of researchers from the different WPs in each working group allows the flexibility of the work flow and a transversal coordination (Figure 5). Thus, the type of final tool and the linked access to data can be discussed in a concomitant way by representatives of WP2, WP3, WP4 and WP5 (see below the steps 7 and 8). Moreover, the involvement of the same partners (working on tool access or covariates, per example) in every case will allow the gathering of information needed for an increase in genericity.

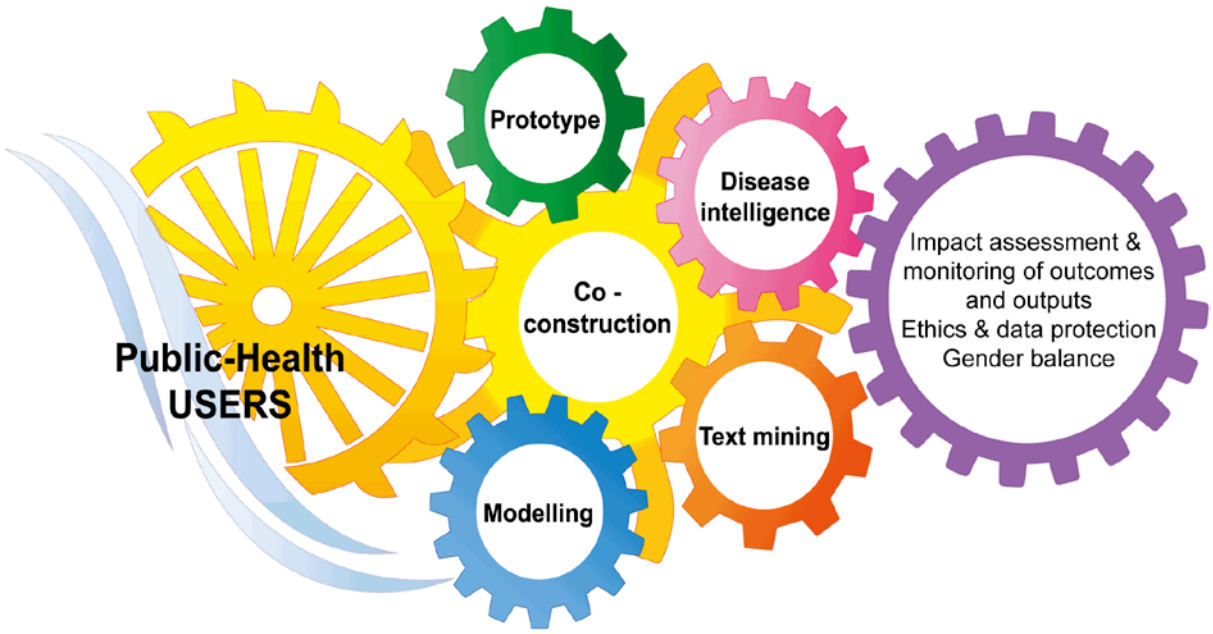

Figure 5: Transversal coordination of the WPs through the case studies

Definition and roles:

- ***Facilitator*** is a person in charge of facilitating the work related to the case study, in order to achieve the objectives of producing tools and solving users' problems (versus academic objectives which are supervised by the WP leaders).
  The facilitator **manages and organizes the exchange with the users** and **MOOD researchers** in link to the case study to address specific questions as defined in the roadmap for his group and makes the link with the interdisciplinary issues and **collaborations between teams of several WPs** in a coordinated way and **monitors the progress** for his group and in collaboration with the animation team.
  The facilitator **produces reports and updates**, and shares with the animation team and the Executive Board (EB). The documents will also be available in Alfresco to the entire consortium. The MOOD coordination will set a dedicated folder for the case studies.
  The facilitator in link with the sociologist, will inform the communication manager wherever there is a major update of the documents (news, events, minutes, reports) by email, Mattermost or videocall. The communication manager will update this information on the MOOD webpage (See section 4 of this document).
  There are as many facilitators as case study working groups. Two facilitators can be proposed if necessary (this is the case for Covid-19).
- **A*nimation team*** is set up to **support and coordinate all case studies** by proposing methodological bases to **harmonize the approaches** in the different groups and to **make the results comparable and interpretable**. This team is composed of a member of the **MOOD coordination** team and a **sociologist**.
  - **Two epidemiologists from the coordination (E. Arsevska, deputy R. Lancelot, Cirad**) will **monitor** the advances of **each case study group** (by being a member of each group), both in terms of methodology and expected results, in close collaboration with the case study facilitators and the sociologist. In close collaboration with the MOOD project assistant **may provide logistical support** to the case study groups for the **events with end-users**, such as **workshops and meetings**.
  - **The sociologist in charge of the user needs assessment (Lead of the D1.1)** will elicit points of vigilance during the process (concerns of users or partners to consider), will give a methodological support to organize the interactions (objectives, steps and validation) and will help the facilitators to write the reports.

  Platform implementation (Avia-GIS) will monitor the case study implementation to collect the information concerning the dataflows and the tools specifications, will check the conformity to the technical requirements and give feedback to the facilitator.
- ***Monitoring team:***
  - **Outcomes assessment:** Epidemiologists from ANSES and INRAE will monitor the outputs, collect the technical assessments done by the researchers and will assess the outcomes for the project. An anthropologist from INRAE and a sociologist from the Lead of the deliverable (GERDAL) will analyse the participatory process and will assess the outcomes for the project in a qualitative way (change of practices).
- ***Communication manager (OGH):*** will produce regular updates about the study cases on a dedicated webpage of the MOOD website in close collaboration with the case study facilitators and where necessary the animation and monitoring team. OGH produces front-end design (e.g. think mock-up graphics of a tool that users then give feedback on). This organization creates and extends training materials for the tools once developed, once operational.
- ***Other members to the case study groups***

- ***End-users:*** Practitioners/users from ECDC and model countries who volunteer to address the chosen needs.
- The ***partners*** involved in developing the technical products useful to address the need (totally or partially) are free to independently contact the users to complete their design work on more generic issues or on diseases that are not part of the case studies. Researchers who are in charge of generic activities (such as covariates, access to tools and the team of the subtask 6.4 "assessment of the outcomes") are included de facto in the case groups. The mobilization of group members depends on the design stage (the group is not systematically mobilized as a whole).
- The ***WP and the task leaders*** remain responsible for the implementation of the activities of their WP or tasks according to the commitments with respect to the European Union (production of deliverables, milestones) and the related academic productions

Ten steps have been identified by the sociologists of the WP1 to describe the progress in the implementation of the case studies (Figure 6). The facilitators will use them as benchmarks during the preparation of the road maps and the meetings with users: the step 6 should be reached in January 2022.

- **Step 1**: Identification of problems to solve and solutions (**needs)** from the deliverable 1.1 and expressed by the users since the beginning of the project (interview, workshop, 13th July meeting, etc.);
- **Step 2**: Identification of the **activities** linked with these needs or objectives (work from task 6.4);
- **Step 3**: Identification of the **users** to be involved in the working group;
- **Step 4**: **Selection of the results/products of research** which need the most interactions with users and **decide** which products are going to be prioritised in the work by case studies. To be validated with WP leaders, partners involved in these activities and users;
- **Step 5 a**: Set up with partners involved in the expected results/products of research the collaborations and precise workflow;
- **Step 5 b:** Prepare a **list of questions** to address with users and **prioritisation** of these questions;
    - Ex: to identify the **dataflows** for which a sustainable access on the long term can be provided (free access) and which ones for sharing.
- **Step 6**: **Contact** the identified users and provide them a preliminary road map;
- **Step 7**: Organisation a **general meeting** with the entire working group to validate the needs and the important questions to address;
- **Step 8**: Organisation of **specific meetings** focusing on precise questions involving part of the working group.
- **Step 9: Testing** in real conditions of use and **adapting the prototypes** with users
- **Step 10: Assess** the added value of the tools, the process of co-construction and the outcomes

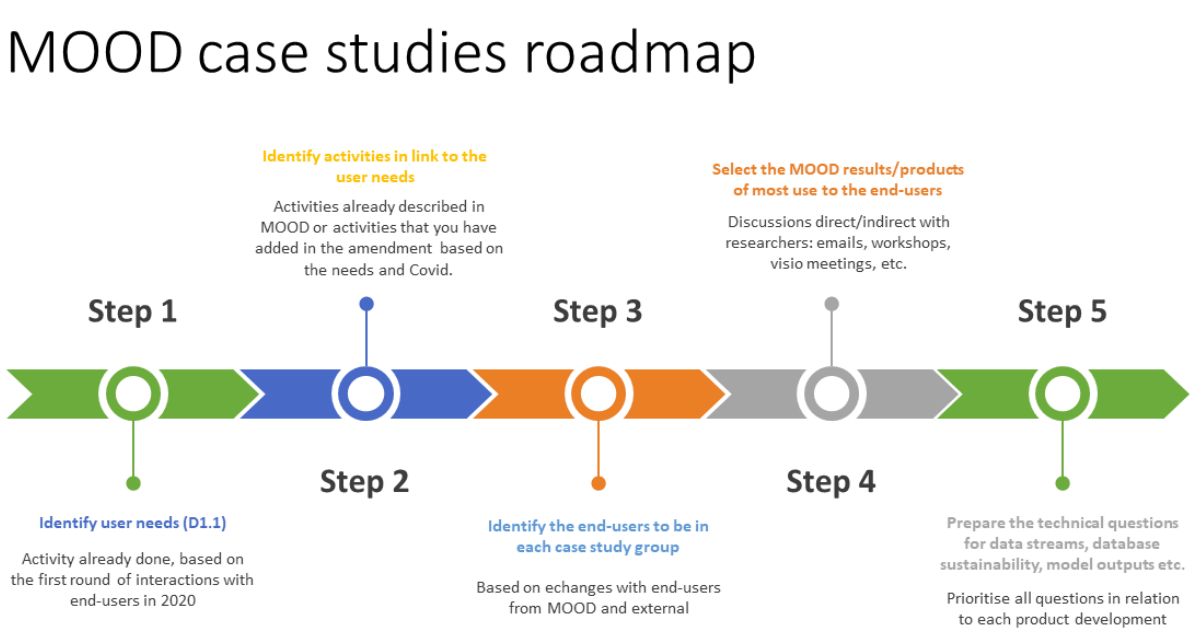

Figure 6: The 10 steps to set up the study cases (step 4 where we are in early December 2021)

3. Project monitoring and evaluation

Through its monitoring and evaluation system the project intends to generate information and make them available to managers, partners and end-users. M&E insights are expected to support adaptive management and learning.
In the table below are presented the main stakeholders of the M&E system as well the type of information they will be expecting from the system and the way in which they will use this information.

Table 1: Stakeholders of the M&E system, type of information managed, and purposes of use of this information.

Users of M&E information	**Type of information**	**When**	**Use**
Project Management Unit	Progress and completion of deliverables and milestones (PCDM) Output indicators Outcome indicators Impact pathway review	Regular meetings Annual meetings Mid-term and final evaluation	Prepare meetings, send reminders, propose planning adjustments and budget reallocations Prepare executive board and steering committee meetings, formulate proposals for adapting operational and strategic planning
Work package leaders	PCDM Output indicators Outcome indicators Impact pathway review	Regular meetings Annual meetings Mid-term and final evaluation	Work package coordination Support Management Unit in overall project coordination
Case study teams	Output indicators Outcome indicators	6-month meetings	Get inputs and insights for learning loops / meeting
Executive Board	PCDM Output indicators Outcome indicators Impact pathway review	Regular meetings Annual meetings Mid-term and final evaluation	Review and adjust operational planning Identify new opportunities and bottlenecks Draw lessons on co-conception, capacity development and dissemination strategies Review and adjust annual and strategic planning Prepare annual reports
General assembly / General public	Output and Outcome indicators	Every year	Communication / Accountability
Funder	PCDM Output indicators Outcome indicators	Annual report	Verify progress made Provide feedbacks on overall project advancement and strategies

The M&E system will be based on the overall IP and on the specific study cases. MOOD partners are being involved in the design and the implementation of the monitoring and evaluation system. As an example, partners' appreciation about the value added by MOOD to their processes and outputs will be an integral part of the M&E system. Partners will also be regularly informed about overall project performances, as they are already involved in the project governance structure and mechanisms.
In order to promote collective learning and to allow for regular adjustments of the initial IP, The project coordination unit and the 7.2.4 task (monitoring of the impact) leader will choose key moments to undertake, based on monitoring data, participatory assessment of activities

realized, new obstacles and opportunities and results achieved. These moments of reflections and learning can take place during dedicated periods in annual workshops for reporting on outcomes and planning of future activities, or during meetings organized to manage study cases. Most probably these assessments will take place during the Executive Board meetings in December and once a year (2022 and 2023) with the case study groups. IP will be revisited and updated based on these participatory exercises.
Specific intermediate evaluation moments, when internal or external evaluators undertake these evaluations, will also be planned. The aim of these participatory sessions is to create spaces where all the stakeholders of the project (users and researchers) can reinforce their common vision and understanding about the overall change process they are contributing to.

3.1 MOOD contributions towards expected impacts and key performance indicators

The review of the IP (started in January 2021) has also created the opportunity to review the key performance indicators (KPI) that MOOD will use to monitor and evaluate its contributions towards the expected impacts (Figure 3 and annex 1 (Figures 7, 8, 9, 10 and 11).
The table below presents an updated version of the table "MOOD contribution towards expected impacts of the call" presented in the initial project document[7].
Two KPI levels (output and outcomes)[8] are presented in the table and the approaches to monitor and evaluate them are presented in the following sections 3.2 and 3.3.
For each indicator a detailed reference sheet has been prepared under the coordination of the monitoring team. The reference sheets are available in Annex 2.

Table 2. MOOD contribution towards expected impacts of the call

Project contribution versus expected impacts of H2020 SC1-BHC-13	
1/ Strengthened EU preparedness to address threats from (re-)emerging infectious disease threats, by making available the appropriate technology and tools for risk modelling and early threat detection, to support an appropriate public health response	
Key Performance Indicator and Target Value	**KPI.1:** (output) Level of co-conception according to the integration of end-users in the innovation process
	KPI.2: (output) Quality of collaboration of the different stakeholders in the co-conception of MOOD tools
	KPI.3: (output) Training: # Health professionals at PH/VH agencies trained to detect, asses and monitor disease threats using MOOD tools
	KPI 4: (output) Compliance of the new tools and services with the H2020 ethics principles and the MOOD internal procedures covering ethics and data protection (The Ethics Management Plan and the procedures of the data protection)
	KPI.5: (output) Compliance of the new tools and services with the H2020 principles and the MOOD internal procedure on intellectual property

[7] The original table was presented as ANNEX 1 – Part B – page 22 of the Grant Agreement number: 874850 — MOOD — H2020-SC1-BHC-2018-2020/H2020-SC1-2019-Single-Stage-RTD

[8] Output: It consists of the product resulting from the intervention, including that which does not come directly from the research if the intervention is not purely a research intervention. It can take the form of scientific or non-scientific knowledge (publication, report, database, method, etc.), professional or academic training, expertise, technology, network or other forms of products.
Outcome: is the appropriation of a research or intervention output by actors interacting directly or indirectly with the research community, leading to change in practices, changes in organizations or in interactions or new rules.

	KPI.6: (outcome) Number of European PH/VH agencies who have used the MOOD tools and models to detect, asses and monitor disease threats after the step of testing
	KPI.7: (outcome) User satisfaction with MOOD tools for detection/ prediction of disease emergencies
	KPI.8: (outcome) % of practitioners in partner agencies having enabled their ergonomics of routine thanks to the MOOD tools and services
	KPI.9: (outcome) Effectiveness of detection and/or assessment of infectious threats
	KPI.10: (outcome) Level of formal inter-sectoral collaborations between VH and PH agencies
2/ Contribution to the European One Health action plan against antimicrobial resistance.	
	KPI.11: (output) Production of one European risk map of AMR emergence (1 regional map)
	KPI.12: (output) Development of a proof-of-concept of an event-based surveillance algorithm/ functionality to detect new AMR events/ outbreaks
	KPI.9: (outcome) Effectiveness of detection and/or assessment of infectious threats
	KPI.10: (outcome) Evaluation of formal inter-sectoral collaborations between VH and PH agencies
3/ Contribution to the digital transformation of health and care within the context of the EU Digital Single Market.	
Key Performance Indicator and Target Value	**KPI.13**: (output) Production and readiness level of MOOD tools for the detection/prediction of emerging diseases
	KPI.14: (output) Project website performance
	KPI.15: (output) Social media performance
	KPI.16: (output) Newsletters performance
	KPI.17: (output) Gender parity in Events
	KPI.18: (output) Publications: nb, type and impact factor (including the gender of first and last author)
	KPI.19: (output) Toolkit & Tutorial/cookbook: nb of tools and tutorials
	KPI.8: (outcome) % of practitioners in partner agencies having enabled their ergonomics of routine thanks to the MOOD tools and services
4/ Contribution to achieving Sustainable Development Goal (SDG) 3 and specifically the targets on: 1) combating epidemics, and 2) strengthening capacity for early warning and response to health risks. Contribution to achieving of SDG 13 and specifically the targets on 1) integrating climate change measures into national policies, strategies and planning, and 2) improving education, awareness-raising and human and institutional capacity on climate change adaptation, impact reduction and early warning.	
Key Performance Indicator and Target Value	**KPI.20** (output): Production and dissemination of disease profiles that take into account the global climate and environmental change on disease emergence
	KPI.21 (output): Integration of climatic, environmental, and other drivers of disease in the models
	KPI.22: (output) Production of European maps for vector, hosts and disease distribution (at least WNV, Usutu, TBE, Avian Influenza)

3.2 Approaches and tools for monitoring and evaluate co-design processes and outputs

Two main dimensions will be monitored:

1. **MOOD products and tools – monitoring participatory co-conception and readiness**

MOOD contribution to expected impact is strongly linked with its effective capacity to co-conceive different products, tools and services together with their users (i.e. PH and AH agencies). It is important then for the MOOD coordination to closely monitor the progress made starting from the initial identification of the users' needs the products, tools and services will respond to and ending with the actual deployment of the co-conceived solution. This deployment will start by the changes of practices by the EI practitioners involved in the case studies and then be disseminated by scaling up (extrapolation of designed tools for other uses or other types of users) and scaling out (availability of the designed tools for other European countries and other non-European countries).

Key evaluation questions*:*

Under which conditions is the co-conception of MOOD tools contributing to the identification and development of well-targeted solutions that are satisfactory for users?

- *Do the MOOD tools address partially or completely the selected user needs (in particular the ones prioritized through the study cases)?*
- *How satisfied are the users with the co-conception process?*
- *How satisfied are the users with the MOOD tools after testing them?*
- *Do the co-development process of identified tools progress as planned by MOOD stakeholders?*

Methods and tools

1 tool - to monitor the development/ readiness of MOOD tools (Inspired by: Technology readiness level, Balanced readiness level assessment (BRLa), Scaling Readiness) developed in the case studies

1 approach - to assess stakeholder participation in co-conception processes (INRAE) (KPI 1 and 23)

1 tool to monitor users' satisfaction about the prototypes

2. **MOOD communication, dissemination and capacity development activities – monitoring and evaluating the level of outreach**

Key evaluation questions:

- *Do the communication, dissemination and capacity development activities contribute in reaching the expected targets?*
- *How satisfied are the different audiences with the format, relevance and applicability of the knowledge shared through communication, dissemination and capacity development activities?*

Methods and tools

1 tool - to collect regular information on capacity development activities implemented

1 tool – to collect feedback on trainees' satisfaction

1 set of tools - to collect regular information on communication and dissemination activities

3.3 The outcomes assessment approach designed and implemented by an interdisciplinary team (task 6.4)

MOOD outcomes: innovation narratives and strengthening of partnership networks

A participatory approach will be implemented to monitor 1) the uptake of MOOD tools; 2) the changes in process/procedures; practices; 3) interactions at the level of H/V public health agencies.

Key evaluation questions:

- *To what extent the co-conception approach has responded to the expectations and motivations of different actors?*
- *To what extent the co-conception approach has influenced the innovation processes? Which are the effects perceived by different stakeholders?*
- *What are the changes in knowledge, practices, interactions reported by different stakeholders? To what extent where they expected / unexpected?*

Methods and tools

A multidisciplinary team of epidemiologists (ANSES, INRAE, CIRAD) and sociologists (GERDAL, INRAE, CIRAD) is responsible for the design and implementation of the objectives and global approach of the outcome assessment method.

Socio-anthropological assessment

The research strategy in socio-anthropology focuses on the monitoring and evaluation of the collaborative approach to the co-production of knowledge and the process of change of EI practices that will start thanks to the study cases and the interactions with EI practitioners. By analysing the effects of this approach on the innovation process, this strategy aims to update outcome indicators relating to changes in knowledge and practices. Concerning the evaluation of the co-design process, the analysis of the parameters of the dialogue between the different actors (in particular by characterising the different groups, identifying their expectations and motivations) and the mapping of their exchange flows should reveal qualitative indicators of participation. Concerning the impact of this approach on innovation, socio-anthropologists produce "innovation narratives" (according to the method consisting in reconstructing the process on the basis of the presentation of key events by the different actors). The comparison of these innovation narratives with the analysis of changes in the knowledge and practices of the actors (users, researchers and designers), carried out throughout and at the end of the project, should provide indicators of the influence of co-design on the innovation process. Beyond the production of such indicators, the various semi-directive interviews conducted with project members and EI practitioners involved in the case studies should also make it possible to identify unintended outcomes and elaborate useful hypothesis for impact scenarios, collaboratively between the socio-anthropology and epidemiology teams.

Epidemiological assessment

The epidemiological assessment aims at evaluating the impact of MOOD innovations on the performances of disease surveillance systems and on end-user practices regarding epidemic intelligence for WNV, AI, AMR, disease X and other emerging disease threats. The assessment of the innovation process will be done by monitoring the MOOD innovations and its impact on the beneficiaries using qualitative key performance indicators. Indicators of the expected changes among end-users at European PH/AH agencies will be chosen using participatory workshop.

Epidemiological indicators will be evaluated in a survey. Outcome implementation and changes will be collected during the learning-loop workshops (Task 1.4), and completed by interviews / survey of end-users, thus allowing to predict the evolution of the epidemiological indicators

at short term and the probable evolution at longer term. The results of this analysis will be completed in the final MOOD report, D.6.6 (M48). They will be used as inputs for the innovation pathway of the project (task 7.2.4).

Objectives of the outcome assessment (task 6.4) by the epidemiologists and preliminary work done

The objectives of the work are:

1. To identify MOOD innovations (software, code/model, database, etc.).
2. To identify and characterize all multi-dimensional changes in epidemiological indicators, interactions, and knowledge linked to the use of the MOOD innovations.
3. To assess the interactions between new practices and the performance of the epidemic surveillance systems. The impact linked to the tools should be distinguished from the other causal events.

Regarding the first objective, we identified and characterized the tools produced within MOOD, by collecting a range of information for each tool: the objective, disease model, method used, expected result(s), output, outcome, impact, sustainability, existing collaborations with MOOD partners and end-users, and potential risks. The information was extracted from the proposal and by contacting subtask leaders and partners for reviewing and updating the work program (e.g., new tool or activity proposed). We contacted 46 participants, and obtained a 93.5% response rate.

The second objective will include two steps:

- Identify/characterize the effects that can be observed during the time of the project for each technical solution and choose the methods to assess them.
- Characterize multi-sectoral collaborations in surveillance of a specific threat: AMR, West Nile, disease X etc.

The third objective is related to multi-sectoral collaborations of surveillance:

- Assess how MOOD innovations allow to reach the objectives of surveillance interoperability and collaborations between sectors and EI systems.
- Assess how MOOD innovations allow to improve (or not) the efficiency of surveillance systems
- Assess how changes in collaboration impact performance criteria of the surveillance system (effectiveness, cost, efficiency…).

3.4. Roles and responsibilities for implementing the monitoring & evaluation system

Project coordination (CIRAD) is responsible for:

- The overall coordination of the monitoring and evaluation system
- Monitoring the completion of deliverables and milestones (see annexes 3 and 4)
- Design and implement the outcome assessment method in coordination with ANSES, INRAE and GERDAL (task 6.4).
- Gathering updates on KPIs every year
- Gathering all needed information to prepare and submit annual technical reports to the funder
- Participating in the design, preparation and facilitation of impact pathway's review and learning loops exercises.

Lead of the deliverable (GERDAL) is responsible for:

- Coordinating the design, preparation and facilitation of impact pathway's review and learning loops exercises.
- Design and implement the outcome assessment method in coordination with ANSES, CIRAD and INRAE.
- Data collection, analysis and reporting on KPIs as defined in indicator sheets.

INRAE is responsible for:

- Design and implement the outcome assessment method (e.g. co-conception process and qualitative assessment of the outcomes) in coordination with GERDAL, CIRAD and ANSES.
- Data collection, analysis and reporting on KPIs as defined in indicator sheets.
- Contribute to the preparation of impact pathway's review (e.g. the results of the outcome assessment will be used as input for the innovation pathways of the project (D7.5)).

ANSES is responsible for:

- Design and implement the outcome assessment method (e.g. tool's effectiveness evaluation) in coordination with GERDAL, CIRAD and INRAE.
- Data collection, analysis and reporting on KPIs as defined in indicator sheets.
- Contribute to the preparation of impact pathway's review (e.g. the results of the outcome assessment will be used as input for the innovation pathways of the project (D7.5)).

AVIA-GIS is responsible for:

- Monitoring of the development of the outputs (TRL) that should be available to the users.
- Data collection, analysis and reporting on KPIs as defined in indicator sheets.

OpenGeoHub:

- Monitoring dissemination of MOOD outputs (knowledge, tools, communication products) through communication and capacity development activities.
- Data collection, analysis and reporting on KPIs as defined in indicator sheets.

All the other partners:

- Data collection, analysis and reporting on KPIs as defined in indicator sheets.

For the design and implementation of an efficient and effective M&E system, a close coordination and collaboration is expected between all the organisations of the MOOD consortium. A closer interaction is expected between:
1) the project manager,
2) the lead of deliverable D7.5,
3) one expert of the ImpresS team from CIRAD.
4) the researchers in charge of monitoring the project innovation process (sociological part and epidemiological part) as part of task 6.4.

4.Results

In this chapter a first attempt at operationalizing the monitoring and evaluation system for a selected set of output level KPIs (14, 15, 16, 18) is made.

KPIs 14, 15, 16

The relevant KPIs related to WP6 are informed by OpenGeoHub over months 19 to 24.

Below are the corresponding progress made corresponding to KPIs 14, 15 and 16.

KPI 14: Project website performance			
	M19 (1 July-30 July 2021)	**M24 (16 November-20 December 2021*)**	**Growth rate**
Positive growth rate for the average session duration	00:01:49	00:02:07	+16.66%
Positive growth rate in website metrics (e.g. visitors / year)	469	537	+14.50%
Blog posts	2	2	n/a

Table 3: KPI 14: Project Website recorded progress. *Report submission date.

Why these KPIs?

Average Session Duration: A session is the period of time a user is actively engaged with the website. All usage data (Screen Views, Events, Ecommerce, etc.) is associated with a session.

Visitors: Visitors who have initiated at least one session during the date range. In order for Google Analytics to determine which traffic belongs to which visitor, a unique identifier associated with each user is sent with each hit. This identifier can be a single, first-party cookie named _ga that stores a Google Analytics client ID, or you can use the User-ID feature in conjunction with the client ID to more accurately identify users across all the devices they use to access your site or app. For more information on identifiers, read about cookies and user identification in our developer documentation.

Interpretation of results

There is a light, but continuous increase in the amount of time visitors are spending on the website. We interpret that this is due to an increase of content (new pages have been launched over the course of the past 6 months, while previous pages have been updated), and increased interest in the new stage of the project (MOOD case studies).

Strategy for next period

We will continue to upgrade and update the website with quality content, making information more easily accessible to both MOOD project partners and end-users. More pages will be created that will include thorough descriptions of the MOOD case studies, key-messages from MOOD deliverables, informative materials (video, infographics, presentations), contacts, events details and updates on activities. In this way, we aim to increase the Average Session Duration. In 2022 we expect a more significant increase in visitation in correlation with the upcoming Summer School and Hackathon events.

KPI 15: Social Media						
	M19 (July 2021)	**M20 (August 2021)**	**M21 (September 2021)**	**M22 (October 2021)**	**M23 (November 2021)**	**M24 (1 -20 December 2021)**
# followers on Twitter	240	243	246	254	270	273
# new followers / month	11	3	3	8	16	3
# tweets / month	2	2	4	7	24	7
# impressions / month	932	818	776	3649	20900	13500

	Average (20 September - 20 December 2021)	**Cumulative (20 September - 20 December 2021)**
% average engagement rate / 4 months	2.0%	Not applicable
# retweets (average) / 4 months	1 retweet / day	77
# clicks on post (average) / 4 months	1 click / day	94

Table 4: KPI 15: Social media recorded progress

Why these KPIs?

New followers: the number of new users who have recently followed the profile.
It is important to track this metric to increase the likelihood of interactions, and successful delivery of messages/content/information from the project.

 # Tweets per month: the number of posts/content published.
This KPI was selected to keep track of the activity and presence of the profile over time.

Impressions: total number of times the Tweet has been seen. This includes not only the times it appears in a one of the followers' timeline but also the times it has appeared in search or as a result of someone liking the Tweet.
Twitter impressions are one of the indicators of project presence in the social medium. If the goal is to increase the visibility of the project, then it's important to monitor how many times produced Tweets have shown up in someone's timeline in a month.

Engagements: Total number of times a user interacted with a Tweet (which includes: clicks anywhere on the Tweet, including Retweets, replies, follows, likes, links, cards, hashtags, embedded media, username, profile photo, or Tweet expansion). This is the basis for the engagement rate, defined as 'number of engagements divided by impressions'. Having a high-level overview of the Tweets engagement rates indicate the most and least successful content types, and overall performance. The overall average is around 0.5%.

Retweets: Times a user retweeted the Tweet
Retweets are a measure of direct engagement with the audience, creating a connection or a conversation.

Clicks on posts: Clicks on a URL or Card in the Tweet.
This KPI tracks the level of interest in the posted content, and it helps to understand the engagement of the audience.

Interpretation of results

The results show a marked increase not only in the number of twitter followers but particularly in twitter followers' activity. This is likely due to a change in post content, focusing on MOOD scientific publications, science webinars, relevant conferences, deadlines for job applications, and other content of interest for MOOD audience. Higher impressions are likely due to a marked increase in the number of Tweets and retweets from the MOOD Twitter profile. Engagement rates follow the same positive trend, likely because a major effort has been put into crafting the content with the use of selected hashtags (#), retweeting activities and tagging MOOD partners or sister projects profiles (@).

Strategy for next period

With improved social media and content acquisition strategies, we plan not only to increase the activity on this social medium, but also to refine the quality of the content through targeted messages, appropriate tagging and selection of relevant hashtags. Thanks to expected novel outputs and MOOD products, as well as upcoming events and activities, we expect to produce more targeted content, as well as to increase the engagement rate with different audience segments. The social media strategy will be therefore updated continuously to best fit the content acquisition strategy with the MOOD coordination team, and MOOD partners.

KPI 16: Newsletters						
	M19 (July 2021)	**M20 (August 2021)**	**M21 (September 2021)**	**M22 (October 2021)**	**M23 (November 2021)**	**M24 (1 December 2021 - 20 December**)**
# of subscribers / month	196	Summer holidays	196	198	209	209
# total opens/newsletter	270	Summer holidays	536	355	177	*
% opening rate/newsletter	21.8%	Summer holidays	20.6%	15.3%	22%	*
# of clicks/newsletter	34	Summer holidays	53	20	33	*
Link to report	MOOD_July Newsletter_Mailchimp.pdf	Summer holidays	MOOD_September Newsletter_Mailchimp.pdf	MOOD_October Newsletter_Mailchimp.pdf	MOOD_October Newsletter_Mailchimp.pdf	*

Table 5: KPI 16: Newsletters recorded progress (not sent yet at the time of report submission*)

** *Report submission date.*

Why these KPIs?

# of subscribers: indicates the total number of subscribers since the beginning of the project, namely since the beginning of the newsletter campaign.
Monitoring total subscribers reveals the 'health' of the mailing lists, tracking changes such as gains, losses or stability and acting consequently.

 # total opens/month: the number of times the campaign (email) has been opened. It gives an indication of interest and outreach.

# of clicks/newsletter are the sum of all clicks recorded during the period an email campaign is live. Total clicks are recorded for any click made, regardless of whether they were made multiple times by certain subscribers/users.

The numbers of clicks in each email campaign indicate the engagement of the readers with the content, once the email has already been opened.

Interpretation of results

Although we see an increase in the number of subscribers, we also see a decline in the number of total opens per month over the last month. This trend could be interpreted as follow: the interest of the readers has declined over the past month, but the opening rate (%), which indicates the number of opened newsletters over the total number of newsletters sent in one month, and number of clicks/newsletter remained stable (on average compared to past months). This could be explained by the fact that the last newsletter was sent in the reporting time (less

time available to read the newsletter), whilst the interest in content of usual readers has remained unchanged. More attention should be given to the date of sending (Friday rather than Monday).
New subscribers have been acquired after important MOOD events (ex. End of July meeting), and a visible sign-up form has been set up on the official website.

Strategy for next period
Similarly, to social media, we expect an increase in MOOD generated content, and therefore news items to be communicated via the newsletters. The behaviour of the subscribers will be closely monitored, as we expect an increase of subscribers with the upcoming Summer Schools and Hackathons. Moreover, design and content of the newsletter will be refined, including more targeted messages to the end users (thanks to MOOD case studies activities), more links to the website (with continuous updates). Major attention will be paid to the date and hour of release.

KPI 18: Publications
22 peer-reviewed papers have been published in 2020 of which 19 (86%) have been published in an impact factor journal > 3 and 9 (41 %) have been published in an impact factor journal > 10. 16 publications (73%) > 10 citations and 6 (27%) > 100 citations.
25 peer-reviewed papers have been published in 2021 of which 21 (84%) have been published in an impact factor journal > 3 and 8 (32 %) have been published in an impact factor journal > 10. 7 publications (28%) > 10 citations.
In the peer reviewed publications in 2020 only 4 women were first author (18%) and 7 women (32%) were last author.
In the peer reviewed publications in 2021, 6 women were first author (24%) and 7 women (28%) were last author.

Interpretation of results
The target has been widely reached concerning the number of peer-reviewed publications of very good quality, their impact factors and number of citations. For the moment the target has not been reached concerning the gender balance.

5.ANNEXES:

Annex 1: Zooms of the different parts of the impact pathway (IP revised in June 2021 and indicators updated in December 2021). Details can be found on the link https://app.klaxoon.com/participate/board/NJAX4CV

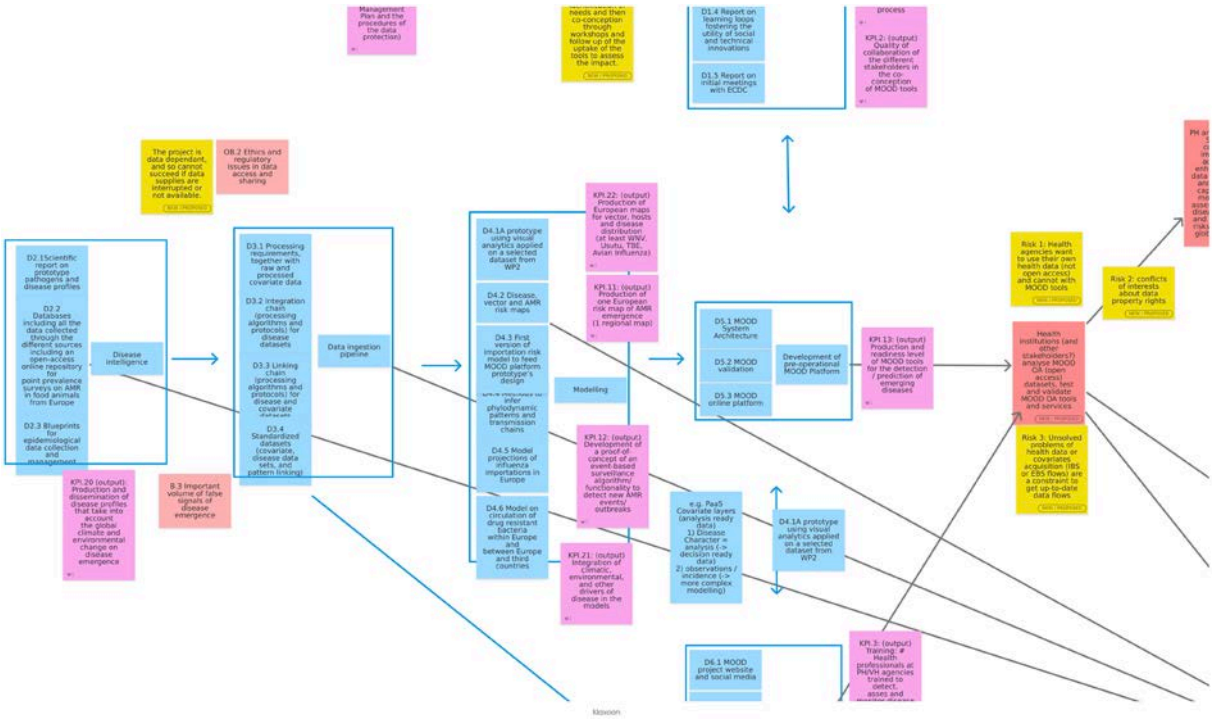

Figure 7: Part of the IP focusing on the inputs of WP2, WP3, WP4 and WP5

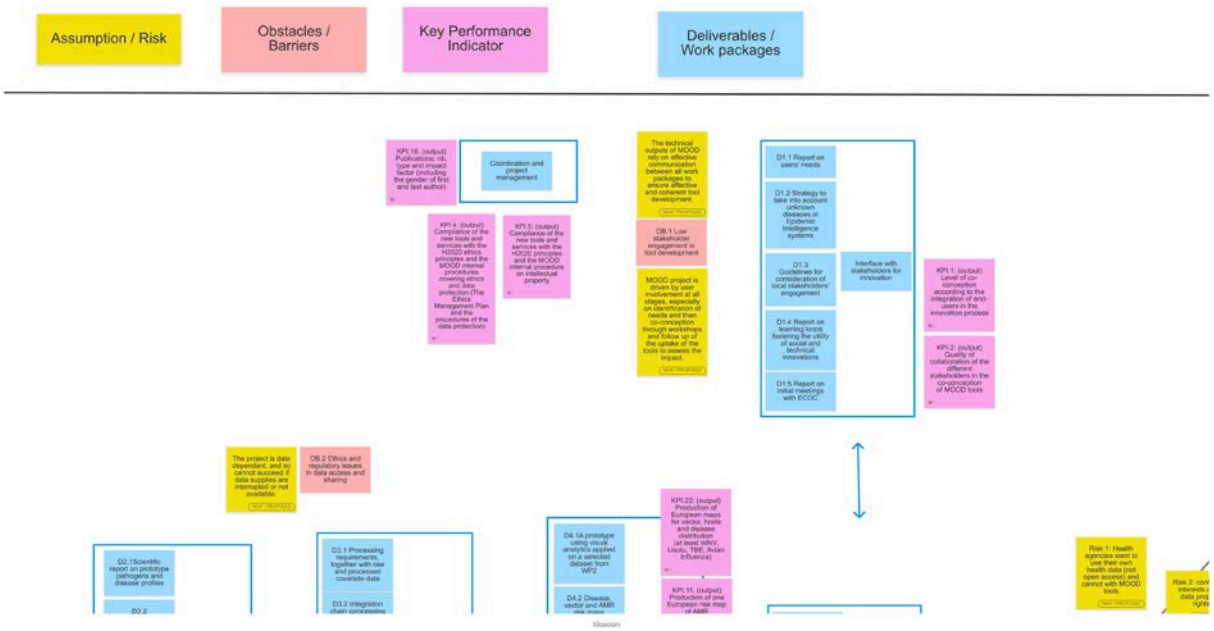

Figure 8: Part of the IP focusing on inputs of WP1 and related KPIs

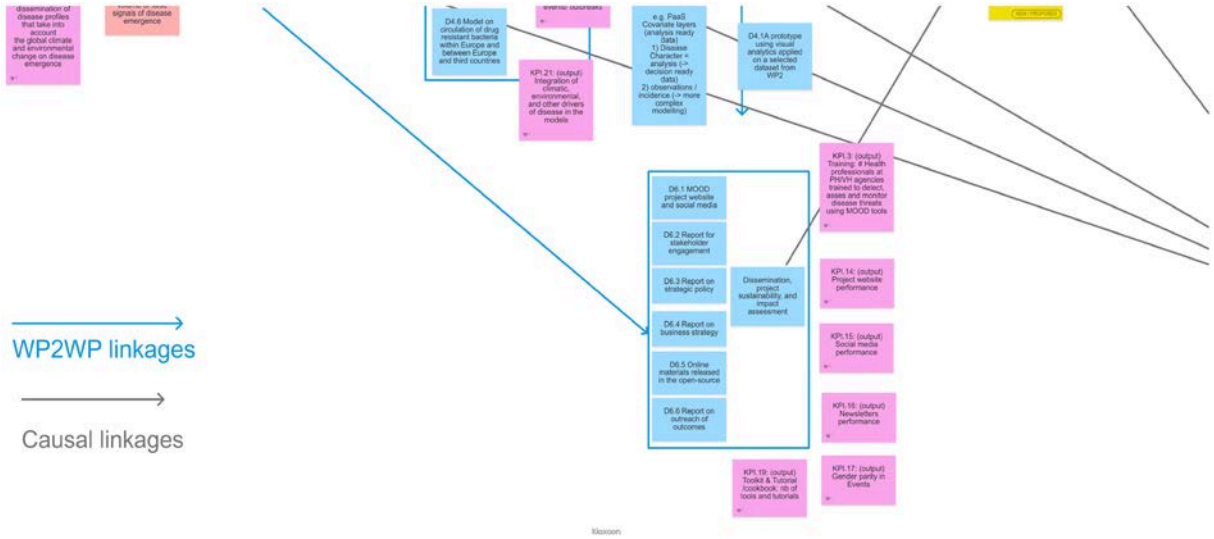

Figure 9: Part of the IP focusing on the inputs of WP6

Figure 10: Part of the IP focusing on the outcomes about AMR

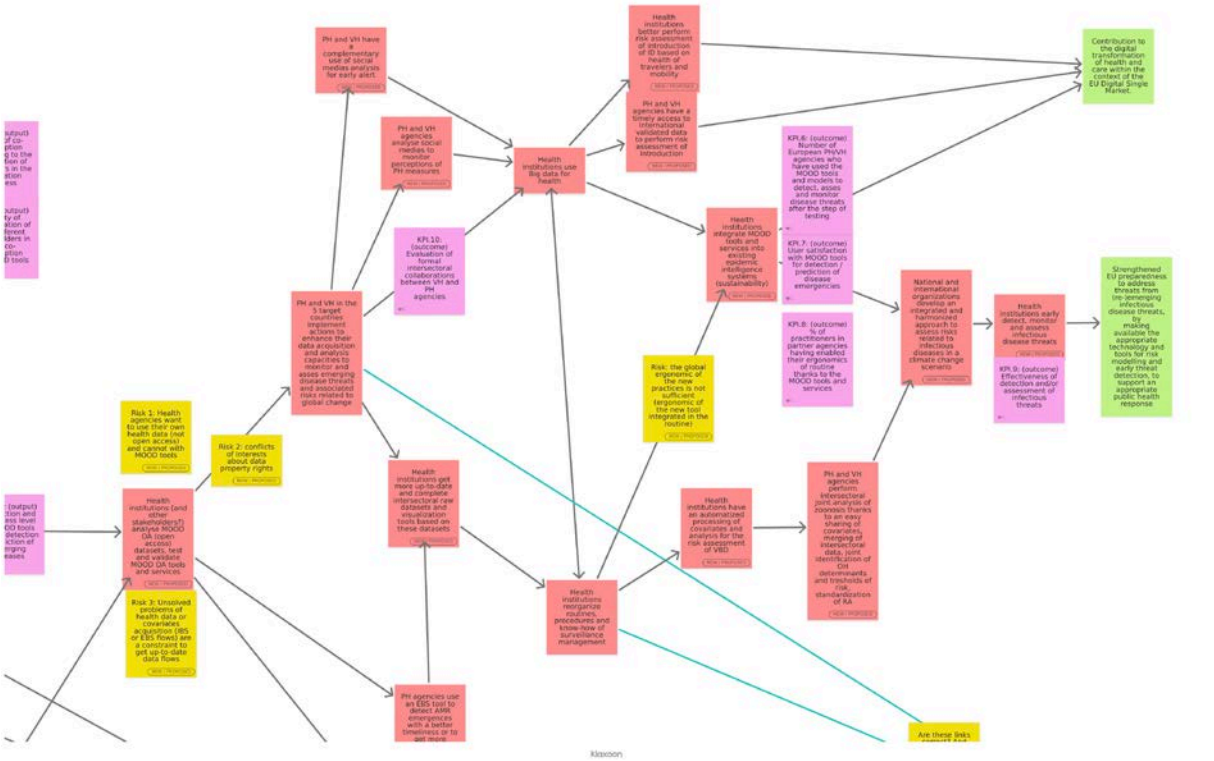

Figure 11: Part of the IP focusing on generic outcomes

Annex 2. MOOD Indicators sheets

Tables describing the Key-performance **Indicators (KPIs)**

Indicator	**KPI 1. Level of co-conception according to the integration of end-users in the innovation process**
Responsible	GERDAL, INRAE
Definition	**Output level** Qualitative and semi-quantitative assessment of the participatory approach adopted for the co-conception of tools. Methodological monitoring of the stages of the participatory co-design approach throughout the innovation process (across time per case study).
Purpose	To assess the level of integration of end-users in the co-design process by analysing the actual and experienced roles of the different actors during the different stages of the process by case studies and across time.
Baseline	Level of participation for the workshops of December 2020 (add number of participants, institutions) + full validation of the statements about their situations and requirements.
Target	An increase of the number of participants/ institutions is expected (+30%) in the case studies. At least 50% of expected agencies/organisations actually participating in conception, testing in real conditions and validation processes.
Data Collection	Observation of collective workshops and/or analysis of sound recordings. Analysis of meeting minutes. Semi-structured interviews with a sample of end-users (years 2 and 3).
Tool	Interview guide for the semi-directive interviews. Internal reports of meetings. List of MOOD tools with basic information (produced under KPI13)
Frequency	Collection in itinere and with focus on important moments of validation. Reporting at M36 and M48.
Reporting	Annual report of Deliverable 7.5 at M36, M48. + D 6.2 + D 6.6
Quality Control	The data provided by reports and semi-directive interviews are verified on the basis of audio recordings of the collective meetings or individual interviews.

Indicator	**KPI.2. Quality of collaboration of the different stakeholders in the co-conception of MOOD tools**
Responsible	INRAE, GERDAL
Definition	We want to describe the collaborations through the network of MOOD (partners) to better understand the quality of collaboration

Purpose	To assess the level of stakeholders' participation, their perception and satisfaction of the collaborations and characterize stakeholders' engagement in case studies.
Baseline	NA
Target	NA
Data Collection	On the basis of a data record, requested from each actor for each of their exchanges over a period of 15 days (during year 3), we will produce a mapping of the actors' network and their exchanges (workflows).
Tool	Interview guide for the semi-directive interviews, questionnaires for the cartography, tool of network modelling. Stakeholder's mapping
Frequency	Year 3 around collective moments
Reporting	Annual report of Deliverable 7.5 at M48.
Quality Control	Results from the questionnaires will be cross-checked with the analysis of the interviews.

Indicator	**KPI.3. Training:** **# Health professionals at PH/VH agencies trained to detect, asses and monitor disease threats using MOOD tools**
Responsible	OpenGeoHub
Definition	**Output level** Starting in 2022, OpenGeoHub will organize training activities (summer schools) for health professionals at PH/VH agencies to detect, assess and monitor disease threats using the tools developed by the MOOD project. The term 'MOOD tools' refers to all the new and/or adjusted procedures and tools for data collection, data processing, data analysis and visualization. This KPI will assess the number of professionals in human and veterinary public health agencies that directly benefited from MOOD training activities.
Purpose	To assess MOOD's efforts regarding the transfer of knowledge and building of capacity to support the change of practices linked to MOOD tools and services.
Baseline	Not available.
Target	At least 10 professionals trained.
Data Collection	The same MOOD staff responsible for each training activity (OGH) will also be responsible for the collection of the information related to trainees using a standardized form. Data will be collected at the completion of each training activity and shared with the project manager as soon as it is available.

	Data collected on trainees will be disaggregated by sex, level of education, organization, country, type of training, training duration, organization responsible for the training, MOOD tool, disease/threat. A short after-training survey to be deployed after each training activity, to quickly collect feedback from trainees on the perceived quality and usefulness of the training.
Tool	Standardized form to collect information on trainees Standardized after-training survey
Frequency	Data will be collected at the end of each event.
Reporting	The project manager will consolidate and analyse the collated data after each of the two training events. Data consolidated and analysed will be presented to the executive board. Progress against expected targets will be analysed, trainees' satisfaction/dissatisfaction will be examined and needed adjustments proposed. Data aggregated at the end of each year will be included in the annual report.
Quality Control	The data provided by the survey are verified on the basis of verified email addresses corresponding to each participant that they belong to a PH/VH institute.

Indicator	**KPI.4: Compliance of the new tools and services with the H2020 ethics principles and the MOOD internal procedures covering ethics and data protection (The Ethics Management Plan and the procedures of the data protection)**
Responsible	AVIA-GIS
Definition	Compliance to H2020 ethics principles is a Grant obligation. A MOOD Ethics Management Plan has been developed and includes the data protection procedures (D8.10 The Ethics Management Plan and D8.2 the procedures for personal data collection and processing).
Purpose	Monitor that tools and services under development and testing have no ethical or data protection flaws and where needed identify the necessary actions to be taken to made them compliant with the H2020 ethics principles
Baseline	Not available
Target	All tools comply with the MOOD internal ethics and Data Protection procedures to make sure the tools to be shared with the public respect the fundamental rights.
Data Collection	Tool developers will provide to AVIA-GIS evidence (internal documents) that ethics requirements are being respected at the different tool development stages. AVIA-GIS ensures information and evidences have been provided for each tool under development before transmitting them to the members of the Ethics Board.
Tool	**Checklist to be designed by the Ethics and DP Advisors** and to be filled by the tool developer during tool development

	- At tool design phase, check if the requirements follow a privacy by design approach. - At tool testing phase and release phase, check that the procedures defined in the MOOD Ethics Management Plan are followed.
Frequency	M36/ M48
Reporting	NA
Quality Control	Review of the checklist by members of the Ethics Board before release of each tool

Indicator	**KPI. 5: Compliance of the new tools and services with the H2020 principles and the MOOD internal procedure on intellectual property**
Responsible	AVIA-GIS
Definition	H2020 principles and the MOOD internal procedure on intellectual property (Cf. D8.12 Report on legal requirement about intellectual property law)
Purpose	Have tools and services free of intellectual property constraints, so that they can be open source or available at a reasonable cost.
Baseline	Not available
Target	All tools comply with IP procedures so that we ensure all legal issues are respected when we share the MOOD tools out public
Data Collection	Tool developers will provide to AVIA-GIS evidence (internal documents) that IP requirements are being respected at the different tool development stages. AVIA-GIS ensures information and evidences have been provided for each tool under development before transmitting them to the project management unit.
Tool	**Checklist to be designed** and to be filled by the tool developer during tool development
Frequency	M48
Reporting	NA
Quality Control	

Indicator	**KPI. 6: Number of European PH/VH agencies who have used the MOOD tools and models to detect, asses and monitor disease threats after the step of testing**
Responsible	ANSES
Definition	**Outcome level**

	Number of national human and veterinary public health agencies that included at least one tool in their regular processes to perform detection, assessment and monitoring activities of disease threats The inclusion of the tools may result or not into official new/adapted guidelines and/or workflows. The term - MOOD tools - indicates all the new and/or adjusted procedures and tools, as well as services provided by MOOD, for data collection, data processing, data analysis and visualization. For this indicator, we will focus on the tools and services developed in the framework of the study cases. Assessment of tools' use will be conducted by country, agency, MOOD tool, disease/threat.
Purpose	To assess the level of uptake of MOOD tools by national partners, understand drivers and bottlenecks for uptake.
Baseline	NA
Target	At least 10 agencies x tool combinations
Data Collection	Survey and/or semi-structured interviews with representatives of the human and veterinary public health agencies partnering with MOOD. Analysis of meeting minutes (study case teams' regular meetings). Review of national agencies' guidelines and workflows for detection, assessment and monitoring of disease threats.
Tool	Questionnaires and guidelines for semi-structured interviews List of MOOD tools with basic information (see KPI 13)
Frequency	M34, 46
Reporting	D7.5
Quality Control	Data collected by the epidemiologist (task 6.4) must be checked with the anthropologist' ones.

Indicator	**KPI 7: User satisfaction with MOOD tools for detection/ prediction of disease emergencies**
Responsible	GERDAL, INRAE
Definition	**Outcome level** Proportion of professionals in human and veterinary public health agencies that state that the MOOD tools they tested offer a better solution for detecting or predicting emergencies. The evaluation will be broken down by the criteria mentioned by the users during the interviews. The term - MOOD tools - indicates all the new and/or adjusted procedures and tools for data collection, data processing, data analysis and visualization.

	Data collected on user satisfaction will be disaggregated by sex, level of education, agency, country, MOOD tool, disease/threat.
Purpose	To assess the perceived technical advantage of the MOOD tools in comparison with the current tools regarding the users' criteria (resolution, nature of data, new workflows etc)
Baseline	NA
Target	At least 70% of the users surveyed consider that the tools produced by MOOD offered an advantage over the tool they were previously using.
Data Collection	Data to inform this indicator will be collected together with data for KPI.8. Online questionnaire fulfilled by all end-users after testing the prototypes. Semi-quantitative assessment of performance criteria will be combined with qualitative feedback from end-users. Semi-structured interviews with representatives of the human and veterinary public health agencies partnering with MOOD. Analysis of meeting minutes (study case teams' regular meetings).
Tool	Online questionnaire (completed by a phone interview with a subset of end-users). Guidelines for semi-structured interviews List of MOOD tools with basic information (see KPI 13)
Frequency	Once the prototypes have been tested.
Reporting	M34, M46
Quality Control	Cross-checking of the questionnaires' results and the analysis of interviews.

Indicator	**KPI.8: % of practitioners in partner agencies having enabled their ergonomics of routine thanks to the MOOD tools and services**
Responsible	GERDAL, INRAE
Definition	The proportion of practitioners who declares having a better ergonomics (user-friendliness, simplification of the overall procedure etc) in comparison with their previous routine among those having tested MOOD tools and services.
Purpose	To understand to what extent, how and under which conditions MOOD tools have influenced routines in partner agencies.
Baseline	NA
Target	At least 70% of the staff having tested the MOOD tools and services describe an improvement of their routine in relation with the use of MOOD tools.
Data Collection	By interviews with users involved in the case studies. Interviews will be implemented with a stratified sample of users having tested at least one

	MOOD tool (they will be identified through the study cases) and we will ask them to describe their experience and the way the routine change while using this (these) tool(s).
Tool	Interview guide for semi-structured interviews, Nvivo analysis
Frequency	25-35 interviews will be implemented (one per staff).
Reporting	M48
Quality Control	Cross-checking of the interviews and with KPI 6 and 7.

Indicator	**KPI.9: Effectiveness of detection and/or assessment of infectious threats**
Responsible	ANSES, INRAE
Definition	Effectiveness will be measured qualitatively, semi-quantitatively or quantitatively with appropriate epidemiological indicators, depending on study cases and type of tools
Purpose	Evaluation of the epidemiological performances of tools and services developed in MOOD for infectious threats detection and assessment
Baseline	Performances of existing tools and user practices (i.e. before the transfer of MOOD tools and services)
Target	At least one tool per study case
Data Collection	Qualitative and semi-quantitative interviews/questionnaires or/and quantitative evaluation of epidemiological performances.
Tool	Questionnaires and guides for interviews
Frequency	Once per tool
Reporting	M48 (D6.6)
Quality Control	Quality control according to the state of the art of the methods chosen.

Indicator	**KPI.10: Level of formal inter-sectoral collaborations between VH and PH agencies**
Responsible	ANSES
Definition	Identification and description of the collaborations between VH and PH agencies involved in the EI of emerging threats. Characterization of organizational and operational capacities, and impact of the collaboration.

Purpose	To assess the collaborations between PH and VH agencies using MOOD tools and services and identify the extent in which collaborations were improved by using those tools and services
Baseline	NA
Target	-
Data Collection	Data collection (survey or semi-structured interview) on KPI 6 and 10 will be combined
Tool	Questionnaire (or guidelines for interviews)
Frequency	Once for each disease-country combination studied
Reporting	Deliverable 6.6 (M48)
Quality Control	-

Indicator	**KPI.11: Production of one European risk map of AMR emergence (1 regional map)**
Responsible	ETH
Definition	**Output level** The map for VH professionals will illustrate geographic variation in AMR across EU member states, based on point prevalence surveys (sub-national level), and EFSA (national level). The final tool will be integrated to resistancebank.org.
Purpose	The Resistancebank map will be completed for Europe. The point prevalence resistance rates compiled in WP2 (Task 2.2.5) will be interpolated to provide continuous map across Europe. The methodology is an ensemble modelling approach combining LASSO regression, Boosted Regression Trees, and LASSO-GAM. The trends derived from the geospatial mapping will be validated again national trends in AMR reported annually by ESFA.
Baseline	NA (there is no maps comparable).
Target	To get one map available to end-users
Data Collection	
Tool	
Frequency	M48
Reporting	D.4.2. Disease, vector and antibiotic resistance risk maps (M48)
Quality Control	The map will be crossed checked against EFSA data. The resolution and other specifications will be validated by users.

Indicator	KPI 12: Development of a proof-of-concept of an event-based surveillance algorithm/ functionality to detect new AMR events/ outbreaks
Responsible	**ITM, CIRAD**
Definition	To characterize the contribution to the development of a proof-of-concept of an **event-based surveillance** algorithm to detect **new AMR events/ outbreaks** in complement to IBS systems for AMR: by defining objectives, signals and outcomes, and where suitable text mining algorithms.
Purpose	This is an exploratory work that will allow to assess the need for identifying signals and relevant key words for AMR events in unstructured data (e.g. news outlets) in addition to existing IBS systems in Europe. Subsequently, the work will explore the potential for using text mining algorithms to detect new AMR events/outbreak in unstructured data.
Baseline	NA
Target	To determine the potential for developing a text mining algorithm for EBS for AMR
Data Collection	Internal reports in the framework of the AMR study case.
Tool	Meetings with users
Frequency	Assessment at the end of the AMR study case.
Reporting	M48
Quality Control	Validation by the AMR study case group.

Indicator	KPI.13: Production and readiness level of MOOD tools for the detection/prediction of emerging diseases
Responsible	Avia-GIS
Definition	**Output level** The term - MOOD tools - indicates all the new and/or adjusted procedures and tools, as well as services provided by MOOD, for data collection, data processing, data analysis and visualization. For this indicator, we will focus on the tools and services developed in the framework of the study cases. Many datasets, tools and services have been proposed in the MOOD proposal and then adapted during the program review and further finetuned/prioritised at the Paris meeting (Dec8-9, 2021) The challenges for MOOD will be to reach the development steps (building of prototypes, testing, finalization *of* the prototypes, dissemination) according to the agreed priorities and expected TRL levels. Proportion of datasets, tools and services developed and disseminated in comparison in the number of the ones proposed in the priority list for each selected disease within the framework of study case.
Purpose	Periodic monitoring of progress in each study case by study case facilitators and teams will enable to review and adjust the proposed plan. Information timely communicated to project coordination unit will be used to identify

	positive advancements and bottlenecks as well as cross-case learning opportunities.
Baseline	The number of tools, datasets and services proposed (list produced by the monitoring team based on the reviewing of planned activities and the conclusions of the Paris meeting, December 2021) Cf. Annex 5
Target	Targets will be defined by each disease group. Each group will identify and prioritise a series of tools and their expected TRL by the end of the project.
Data Collection	To be included after Paris meeting: priority list and expected TRL at end project. Organisations responsible for this indicator (ANSES, AVIA-GIS) will provide standard formats and guidelines to assess and document tools and their TRL levels. Once a year, study case teams will be responsible for filling-in the requested information and for providing supporting evidence for the TRL level claimed. ANSES and AVIA-GIS are responsible for checking the completeness of the information provided.
Tool	To be included after Paris meeting: priority list and expected TRL at end project.
Frequency	M36, M48
Reporting	On-line summary spreadsheet with milestones.
Quality Control	Results of tool demonstration tests conducted by each tool developer. ANSES and AVIA-GIS are responsible for checking the completeness of the information provided.

Indicator	**KPI.14: Project website: Average session duration** **Website metrics (e.g. visitors / year)** **# of blog posts on the project website/ month**
Responsible	OpenGeoHub
Definition	**Output level** MOOD Website is the official project website, and consists of 7 main pages and a general landing page. A series of metrics have been selected to measure the usefulness and visibility of the website in disseminating MOOD's communication material. 'Average Session Duration' indicates the average length of a visit to the website. Session duration is an important KPI because it gives an indication of the quality of the content and how incentivized users are to stay, read, and click deeper into the site architecture. (A session is defined by a visit to the website, the actions taken by the user during that visit, and then the exit of the user from the site.) '# visitors/year': as these KPI's are reported on a yearly basis this is the length of time during which the number of individual visitors visit the website. '# blog posts on the project website/month' refers to the amount of blog posts uploaded to the website on a monthly basis.

Purpose	To assess the level of visibility and engagement of the website as the official source of information regarding the MOOD project outputs, dissemination and communication services among MOOD partners, end users and general public.
Baseline	Analysis conducted in the Annual Progress Report in M18 & M24 for new metrics
Target	Average Session Duration: +% growth in minutes per session 'Visitors/year': +% growth in visitors per year 'Blog posts on the project website/month': 2 blog posts on the project website/month
Data Collection	Qualitative analysis of the metrics obtained through Google Analytics under "Acquisition". Calculation of the growth rate based on the baseline values and time period.
Tool	Audience Overview report in Google Analytics
Frequency	Metrics will be used regularly in the social communication strategy but collected every six months and will focus on important moments of validation: reporting at M26, M36, and M48.
Reporting	Annual general progress report (M24, M36, M48)
Quality Control	Average values for the selected KPIs will be collected directly from Google Analytics and assessed against the values of previous reports by the communication officer to track variations.

Indicator	**KPI.15: Social Media:** **# followers on Twitter** **# new followers / months** **# tweets / month** **# impressions / month** **% average engagement rate / 6 month** **# likes on post (average) / 6 months** **# retweets (average) / 6 months** **# clicks on post (average) / 6 months**
Responsible	OpenGeoHub
Definition	**Output level** Key Performance Indicators have been defined in order to best assess the level of visibility of the project on Twitter and the level of interest in the content by followers. '# followers on Twitter': self-explanatory. '# new followers / months': self-explanatory. '# tweets / month': self-explanatory. '# Impressions / month': number of times users saw the Tweet on Twitter. '% average engagement rate / 6 months': Number of engagements divided by impressions. Most would consider 0.5% to be a good engagement rate for Twitter, with anything above 1% being very good. '# likes on post (average) / 6 months': Average number of likes per post. '# retweets (average) / 6 months': Average number of retweets per post. '# clicks on post (average) / 6 months': Average number of clicks per post.

Purpose	Twitter plays the most prominent role in social media outreach to health professionals, academics, policy and business decision-makers, and additional target audiences. Posts on Twitter frequently include links to materials located on the MOOD project's website in order to generate traffic to all available MOOD project online resources.
Baseline	Analysis conducted in the Annual Progress Report in M18
Target	# of followers on Twitter: 300 # new followers / months: 10 # of tweets: 5 per month # average impressions / month: >200 % average engagement rate / 6 months > 1% # likes on post (average) / 6 months: 1 like/ day # retweets (average) / 6 months: 1 retweet/ day # link clicks on post (average) / 6 months: 1 click/ day
Data Collection	Statistical analysis of Twitter metrics, using the average over a 6-month period.
Tool	Twitter analytics
Frequency	Collection will be done monthly or every 6 months and with focus on important moments of validation: reporting at M26, M36, and M48.
Reporting	Annual general progress report (M24, M36, M48)
Quality Control	Average values for the selected KPIs will be collected directly from Twitter Analytics and assessed against the values of previous reports by the communication officer to track variations.

Indicator	**KPI.16: Newsletters** **# of subscribers** **# total opens/month** **% opening rate/month** **# of clicks/month**
Responsible	OpenGeoHub
Definition	**Output level** '# of subscribers': Amount of contacts the campaign newsletter was sent to. '# total opens/month': Indicates the total number of times the campaign was opened by recipients. This count includes multiple opens from individual recipients. '% opening rate': Illustrates how many newsletter were opened against the total number of newsletter mails sent, giving a relative perspective on the actual number of newsletters read. '# of clicks/month': To investigate the interest in the content, the total number of clicks per month are analysed, counting the total number of times tracked links were clicked by recipients. This count includes multiple clicks from individual recipients.
Purpose	To assess and monitor the interest of MOOD's newsletter receivers in the latest advancement and findings related to MOOD.

Baseline	Analysis conducted in the Annual Progress Report in M18
Target	An increase of at least 50 new subscribers over the next 6 months; An average of 200 opens per each newsletter; An average opening rate >15% per month; An average of 20 clicks per month.
Data Collection	Statistical analysis of MailChimp metrics, using the average over a 6-month period.
Tool	MailChimp analytics
Frequency	Collection every 6 months and with focus on important moments of validation: reporting at M26, M36, and M48.
Reporting	Annual general progress report (M24, M36, M48)
Quality Control	Average values for the selected KPIs will be collected directly from MailChimp analytics tool and assessed against the values of previous reports by the communication officer to track variations.

Indicator	**KPI.17: Parity of gender in Events:** **% Parity of gender in teachers for Summer School** **% Parity of gender in participants for Summer School** **% Parity of gender in teachers for Hackathon** **% Parity of gender in participants for Hackathon**
Responsible	OpenGeoHub
Definition	**Output level** As part of the dissemination activities, MOOD WP6 will organize a number of events targeting external audiences for capacity building linked to the MOOD tools and services. Beside PH and VH professionals, OGH is aiming to train young professionals, PhD and postdocs in the field of data science. In support of gender parity policies, and MOOD's strategy on gender, OGH is aiming to reach a balanced number of participants between genders, both in trainers and trainees.
Purpose	To increase gender representativeness in lecturers, and encourage all genders in training activities, based on the OGH's gender policy.
Baseline	Each event will be assessed against itself.
Target	For each Summer Schools in 2022 and 2023: Minimum of 40% of female participants Minimum of 40% of female teachers/trainers For each Hackathons in 2022 and 2023: Minimum of 40% of female participants

	Minimum of 40% of female teachers/trainers
Data Collection	MOOD staff responsible for each training activity (OGH) will collect the information related to trainees using a standardised form. Data will be collected at the completion of each training activity and shared with the project manager as soon as it is available. Data will be collected on gender as it relates to participants and teachers/trainers.
Tool	Standard online form
Frequency	Event based (2 x summer schools, 2 x hackathons minimum)
Reporting	Annual report of Deliverables & Activities: M24, M36, M48
Quality Control	The data provided by the survey (see KPI 2) are verified on the basis of verified email addresses corresponding to each participant.

Indicator	**KPI.18: Publications:** **number, type and impact factor (including the gender of first and last author) of MOOD publications**
Responsible	**CIRAD Coordination**
Definition	**Output level** Nb of MOOD publications, type of article (peer-review vs non-peer-reviewed), nb of citations, average impact factor, nb of women first and last author
Purpose	To assess the quality of the research and innovations of MOOD through the publication in impact factor and peer-reviewed journals, as well as high number of citations and equal gender representation among first and last authors.
Baseline	NA
Target	At least 15 articles per year in peer-reviewed journals in the domain of epidemiology and data science with impact factor of at least 3.0, at least 20% of the publications with an impact factor > 10 and at least 10 citations. An equal representation of women and men as first and last author is also a goal.
Data Collection	Excel file with information on the MOOD publications, updated each time there is a new publication. The file is available in ALFRESCO with detailed information per article. On the MOOD website we keep the main article information.
Tool	Microsoft office excel
Frequency	Annual
Reporting	M12, M24, M36, M48

Quality Control	Internal publication procedure of verification of the content (and especially regarding the stigmatisation and discrimination) of the articles before submission with the MOOD partners. Accepted peer-reviewed articles vs non-peer reviewed articles.

Indicator	**KPI.19: # Toolkit & Tutorials for developed datasets and tools/cookbook**
Responsible	OGH/ Avia-GIS (with input from each dataset and tool developer)
Definition	**Output level** Tutorials describing the use of each developed dataset and tools for use in the summer schools. Number of tools, datasets, tutorials downloaded
Purpose	Ensure that the developed datasets and tools are well documented to ensure they are as usable as possible.
Baseline	Priority list and anticipated development stage of datasets and tools developed during the project lifetime.
Target	Tutorials developed for each dataset and tool that will be at TRL9 by the end of the project.
Data Collection	Priority list and anticipated development stage of datasets per selected disease: to be included M26 after user learning loop.
Tool	Priority list and anticipated development stage of tools per selected disease: to be included after M26 after user learning loop.
Frequency	M48
Reporting	Part of the on-line summary spreadsheet with milestones
Quality Control	Tested as part of the tool demonstration activities by tool developers.

Indicator	**KPI.20: Production and dissemination of disease profiles that take into account the global climate and environmental change on disease emergence**
Responsible	FEM
Definition	**Output level** In-depth disease profiles for the 5 model diseases: Covid-19, AMR, WNV, TBE and Avian influenza + but also tularaemia, Chikungunya, Lyme. These disease profiles will be gathered in a book available on MOOD website.
Purpose	The in-depth description is complex since it implies the analysis of epidemiological data and environmental data which are obtained from different sources (ECDC, OIE, existing covariates databases, and national agencies); Consideration of global climate and environmental changes on disease emergence in disease profiles.
Baseline	No disease profiles disseminated.

Target	To have produced at least these 5 disease profiles available in the MOOD book. At least 100 downloads/ from at least 10 countries
Data Collection	Number of downloads of the book.
Tool	MOOD website
Frequency	M30, M40, M48
Reporting	
Quality Control	Publication of MOOD book will follow at least internal review. Number of disease profiles included in the book will be easily verifiable. Number of downloads and locations of users will be collected from the website.

Indicator	**KPI.21: Integration of climatic, environmental, and other drivers of disease in the models**
Responsible	Oxford
Definition	**Output level** Datasets for climatic, environmental, and other drivers of disease, including hosts and vector distributions should be provided for all the model disease to MOOD partners and users for modelling and other analyses
Purpose	Assessing disease risk requires driver datasets to estimate the risk of disease. These data will be provided either directly on request or via the MOOD platform for each model diseases.
Baseline	None
Target	These should be provided for all project priority diseases.
Data Collection	Records of data requests will be kept and access to dataset via MOOD platform will be recorded
Tool	Request records and MOOD platform access metrics
Frequency	Annual
Reporting	Annual
Quality Control	Not relevant. Access metrics and request records are not vulnerable to quality degradation

Indicator	**KPI.22: Production of European maps for vector, hosts and disease distribution (at least WNV, Usutu, TBE, Avian Influenza)**
Responsible	**ERGO, ULB**
Definition	**Output level**

	The production of European maps is finalized and the maps (a complete set per model) are available for users.
Purpose	Subtask 4.2.2. Mapping vector distributions. UOXF, ERGO. Leader: ERGO (M1-M48). Vector distribution is needed to support the mapping of vector-borne diseases as well as an input to the model of risk of importation and onward transmission (Task 4.3). Similar SDM algorithms will be applied to vector distributions, and will also involve the compilation of already published vector distribution data and maps both at the European and Global level. Here too, the identification of the species to be mapped, the relevant predictor variables and their integration into a spatial database will be carried out by WP2 and WP3. Subtask 4.2.1. Mapping disease distribution. SIB, ULB. Leader: ULB (M1-M48). Risk mapping techniques based on Species Distribution Models (SDMs) will be applied to disease distribution data with a careful selection of predictor variables. The disease data and relevant predictors will be defined in WP2 (Task 2.1) and the predictor variable data will be prepared by WP3 (Task 3.1). The task will also involve the compilation of existing risk maps. A specific aspect of this task will be to compare risk maps produced by different type of disease input data. Risk maps produced from different types of disease signals produced by WP2 (e.g. traditional surveillance, text mining, HealthMap) will be produced according to users' needs and compared.
Baseline	NA
Target	To produce at least one diseases distribution map per model disease.
Data Collection	Maps centralized by WP5 (MOOD platform).
Tool	
Frequency	M48
Reporting	D4.2
Quality Control	Maps will be peer-reviewed (publications) and validated with end-users.

Annex 3: Report of the MOOD case studies meeting (December 2021)

Summary of outputs and actions - MOOD Disease Case Study Meeting, December 2021

Prepared by Ichsani Wheeler, OpenGeoHub.org
Facilitation & internal communication activities
Reviewed by Elena Arevska, Timothée Dub and Fanny Bouyer

Executive summary

This meeting aimed to present and discuss the progress of each case study as their temporality is very different, to better define the final outputs and outcomes that will be developed by case study, as well the generic tools (cf. infra) as the very specific ones (Cf. the matrix of MOOD tools) and to set up the collaborations needed (between partners and with users). Thus, an analysis of the TRL levels has been applied and an action list has been decided for the next steps (2023).
The annex 1 presents the intersectoral differences of mandatory notification that are useful to build the strategy of health data collection.

Linked documents:

Overview outcomes of matrix approach are summarised here: MOOD_tools_matrix
Described here: MOOD PlatformDevelopment TRLlevels V2.docx
MOOD Xmas event with summary: MOOD XMAS Event Intro

General tool groups for development:

General tools for event-based surveillance

1a. PadiWeb + ProMED (tbc) connected to visualisation engine (EpiVis)

General tools for risk mapping

2a. Access to expert risk maps
2b. Automated dynamic risk maps
2c. User modification of 2b

General data access tools

3a. Data visualisation, query, download (vector, host, environment)
Who are the product owners?

General tool groups by disease cases:

	Avian Influenza	TBE	COVID	WNV	AMR	Tul-Lepto	Chi-Den-Zika
1. General tools for event-based surveillance: PadiWeb + ProMED (tbc) connected to visualisation engine (EpiVis)	Y	Y	Y	Y	?	Y	Y
2. General tools for risk mapping: 2a. Access to expert risk maps; 2b. Automated dynamic risk maps; 2c. User modification of 2b	Y	Y	?	Y	?	?	?
3. General data access tools: Data visualisation, query, download (vector, host, environment)	Y	Y	Y / TBC	Y	Y / TBC	Y	Y

Short-term action list:

ITEM	ACTIONS	WHO	WHEN
Next meeting early March, 2022	Doodle for date & location	Everyone? (at least taks leaders, subtask leaders and partners involved in modelling)	ASAP
Set user needs levels	Make thresholds to be able to rank user needs / interests - to be clarified	Ish & Fanny & each facilitator	Early Jan
Disease case studies	Make roadmap of shortlisted tools for case study (to go to users for feedback)	Each case study facilitator with inputs from others, back-end workflows to participate	End Dec
Roadmaps checked with end-users	Either one-to-one or group - decided with each facilitator + Avia-GIS	Each case study facilitator + animation team (Elena, Fanny)	End Jan
Back-end work flow meetings	Meetings with each case study + epis to draft workflows for each shortlisted tool	In detail post roadmap check in. Lead by Avia-GIS. In Cc animation team	End Feb
Technical meeting on general tools for risk mapping (all diseases)	Make a coordinated timeline for development	Modellers! Led by Avia-GIS. In Cc: animation team + monitoring team	End Feb

Technical meeting event based surveillance + visualization	Model developers + user + platform & tool developers	Matthieu, Pascal, Elena. ALL tech parties incl. modellers	End Feb
COVID19 / disease x	Fill and validate table on COVID. Share with partners. Obtain results.	Chiara (INSERM) + all related partners	End Feb
All above to report back by next meeting March, 2022			

Annex 1. MOOD disease models and notification

Disease group	Disease	Notifiable OIE (animal)	Notifiable ECDC (human)(1,2)
Airborne pathogens (all virus types)	Influenza seasonal	N/A	Yes (sentinel and national reference laboratory)
	Avian flu	Yes	No, event-based surveillance
Endemic pathogens transmitted by endemic vectors	Tick-borne encephalitis	No (susceptible dog, goat, sheep, cow, horse)	Yes, but not compulsory in all countries
	Lyme borreliosis	No (susceptible dog)	Neuroborreliosis, only
Exotic pathogens transmitted by endemic vectors	West Nile	Yes (maintenance in nature in birds, dead-end host horses)	Yes, but not compulsory in all countries
	Usutu	No (maintenance in nature birds, dead-end host horses)	No
Exotic pathogens transmitted by invasive mosquito species	Chikungunya	N/A (except monkeys, apes)	Yes, but not compulsory in all countries

	Dengue	NA (except monkeys, apes)	Yes, but not compulsory in all countries
	Zika	NA (except monkeys, apes)	Yes, but not compulsory in all countries
Neglected endemic pathogens with multiple transmission routes and reservoirs	Tularaemia	Yes	Yes
	Leptospirosis	No (maintenance in nature rodents, hosts livestock, cats, dogs, etc.)	No annual report after 2016, but still listed as notifiable…
Complex, anthropogenic disease threats	AMR in animals	No but Yes to EFSA	NA
	AMR in humans		Yes, through EARS-NET: antimicrobial susceptibility testing results from invasive isolates of eight bacterial species
Unknown pathogens	COVID-19	Yes	Yes
	Disease-X	Event-based surveillance (tbc)	Event-based surveillance (tbc)

1. EU case definitions [Internet]. European Centre for Disease Prevention and Control. [cited 2021 Dec 21]. Available from: https://www.ecdc.europa.eu/en/surveillance-and-disease-data/eu-case-definitions

2. All annual Epidemiological Reports (AERs) [Internet]. European Centre for Disease Prevention and Control. [cited 2021 Dec 21]. Available from: https://www.ecdc.europa.eu/en/surgical-site-infections/surveillance-and-disease-data/all-annual-epidemiological-reports