

FORE-Med – the development of a foresight methodology for the prioritisation of animal health research in the Mediterranean area up to 2030

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Mediterranean,
Research coordination,
Strategic Research
Agenda,
Zoonoses.

Summary

Diseases evolve constantly and research is needed to face emerging new threats. Evidences suggest that the impact of such threats will have its peak in the Mediterranean area. The FORE-Med, Foresight project for the Mediterranean, aims at identifying the future challenges on livestock health and aquaculture in this area, to ensure an effective coordination of research activities and the delivery of timely solution to emerging issues. One hundred experts with multidisciplinary background and coming from countries all around the Mediterranean basin were gathered to participate in a think-tank to develop a Strategic Research Agenda on animal health for Mediterranean up to 2030. A tailored foresight methodology was implemented, merging the best fit for purpose techniques (e.g. '7 questions', Social, Technological, Economical, Environmental, and Political (STEPP), analysis, scenario building, and backcasting). Both remote and face-to-face debates were held, to ensure a fruitful exchanges and participation among experts. Research needs were identified and prioritised, both on relevance and on temporal scale. The implemented participative approach allowed for the definition of a research priority list for animal health and aquaculture in the Mediterranean, which served as a basis to build a strategic research agenda. The latter is expected to satisfy the sectors' needs and guarantee a much-needed coordination for research activities in the Mediterranean area.

FORE-Med – sviluppo e realizzazione di uno studio previsionale per prioritizzare le necessità di ricerca in sanità animale nella regione Mediterranea fino al 2030

Parole chiave

Agenda di ricerca
strategica,
Coordinamento della
ricerca,
Foresight,
Malattie emergenti,
Mediterraneo,
Sanità animale,
Zoonosi.

Riassunto

Le malattie infettive sono in costante evoluzione e la ricerca rappresenta uno strumento fondamentale per assicurare risposte efficaci e tempestive ai rischi emergenti che ne derivano. Diversi elementi suggeriscono che l'entità di queste nuove minacce sarà di grande impatto nei paesi dell'area Mediterranea. In questo articolo viene presentato il progetto FORE-Med, un progetto di "foresight" (ossia uno studio previsionale) avente come scopo l'identificazione delle nuove sfide nel settore della sanità animale (ivi inclusa l'acquacoltura) nell'area Mediterranea, al fine di assicurare un coordinamento efficace delle attività di ricerca e per fornire soluzioni tempestive alle minacce emergenti. Il progetto ha coinvolto 100 esperti nelle varie aree d'interesse, provenienti dai diversi paesi del bacino del Mediterraneo. Gli esperti sono stati riuniti in un gruppo di lavoro allo scopo di sviluppare un'agenda di ricerca strategica in grado di guidare la sanità animale nell'area Mediterranea fino al 2030. Per lo studio è stata sviluppata una metodica di foresight ad hoc, selezionando e usando in sinergia le metodologie più adatte allo scopo ("7 domande", STEEP analisi, costruzione di scenari e backcasting). Gli incontri del gruppo di esperti coinvolti nel progetto sono stati tenuti in remoto e in presenza, in modo da assicurare la partecipazione più ampia possibile, garantendo al contempo uno scambio proficuo tra gli esperti. Nel corso dei lavori sono state identificate le tematiche sulle quali la ricerca dovrà concentrarsi nei prossimi anni, tematiche che sono state categorizzate sulla base della loro rilevanza e su scala temporale. L'approccio

partecipativo implementato nell'ambito di FORE-Med ha portato, dunque, alla definizione di una lista di priorità di ricerca per la sanità animale nell'area Mediterranea che servirà come base per la creazione di un'agenda strategica in grado di soddisfare le esigenze del settore e garantire il necessario coordinamento delle attività nell'intera regione.

Introduction

Diseases do not respect borders. The enhanced movements of people and animals across countries, due to globalisation and easing of transport, are likely to increase the incidence of emerging infectious animal diseases (Wentholt *et al.* 2012). A marked transition in migration flows was observed in the Mediterranean basin in the last few decades, where several Southern European countries had evolved from emigration to net immigration country, receiving a positive demographic transition from the South-Eastern part of the basin, and this trend is expected to endure in the next future (Bommes *et al.* 2014). Thus, the increase in migration flows might entail new public health challenges across countries (Vittecoq *et al.* 2014). In addition, climate change is known to increase, both directly and indirectly, communicable diseases (Cox *et al.* 2012, Nichols *et al.* 2014). Climate change is expected to affect all livestock systems, and in particular non-grazing ones (López-i-Gelats 2014), and this could be undermining food security and cause social and economic concerns. At the same time, to date, animal health remains neglected and poorly represented in most policy agendas (Coker *et al.* 2011). These changes are expected to have major impact on the Mediterranean basin, in particular for what concerns the risk of emergency of infectious diseases in the area (Vittecoq *et al.* 2014), exerting consequences not only at local, but also national and international level (Wentholt *et al.* 2012). Veterinary services often suffer from lack of resources (Fears and Muelen 2012), and the current reduction of financial availability across different countries might exacerbate the crisis in case of outbreaks.

Research is fundamental to ensure the development of adequate disease prevention and control tools (Wentholt *et al.* 2012) as well as to make better use of already available evidences, and for modelling disease impact (Fears and Muelen 2012). Despite the European Union (EU) policy push toward research and innovation (McCarthy *et al.* 2013), the vast majority of public research in Europe is still funded at national level (Könnölä and Haegeman 2012), with the different funding bodies often operating independently and being guided by local priorities. This situation is even emphasised in non-EU Mediterranean countries, where international

research coordination is scarcer. Consequently, research duplication, lack of success in reaching a critical mass and in identifying research gaps, and incomplete availability of research outcomes are common issues. The progressive reduction of public funding, as well as the enhanced need of preparedness for emergent diseases, pose the pressing need to prioritise research and to prevent unnecessary duplication (Cox *et al.* 2012, Gaunaud *et al.* 2012). Increasing the collaboration on research programming across borders is deemed an appropriate tool to address such needs (Könnölä and Haegeman 2012, Wentholt *et al.* 2012).

In 2005, in response to an initiative of the EU Standing Committee on Agricultural Research, the Collaborative Working Group on European Animal Health and Welfare Research (CWG) was established. The aims of this group, encompassing representatives of funding bodies from over 20 European countries, were the sharing of information and coordination of research activities, and the definition of a common research agenda. Several actions have been initiated in the EU under the auspice of the CWG, with the aim to improve transnational collaboration in research and to start a European coordination of research to define a coherent European research area. In this framework, networks between research funders on animal health were established through 3 EU funded initiatives, the EMIDA ERA-Net (European Research Area Network on Emerging and Major Infectious Diseases of Livestock 2008-2011), STAR-IDAZ Global Net (Global Strategic Alliances for the Coordination of Research on the Major Infectious Diseases of Animals and Zoonoses, 2011-2015), and ANIHWAs ERA-Net (European Research Area Network on Animal Health and Welfare, 2012-2015). Of these 3 initiatives, EMIDA represented the first experience in attempting to define research needs on animal health with a participative approach across Europe, delivering the first European Strategic Research Agenda (SRA) on animal health. Among the final recommendations of this agenda, the need for further updating and detailing of the identified needs was clearly stated (EMIDA 2011). In addition, the EMIDA exercise pointed out the lists of research topics which proved to be quite similar both at pan-European and sub-regional (Atlantic, Nordic/Baltic, Continental and Mediterranean) level, with the exception of the ones from the Mediterranean region, which was then said

to require further specific attention in developing a Strategic Research Agenda (EMIDA 2010). The STAR-IDAZ project was the starting point to reach this aim. It aimed at improving research coordination on the major infectious diseases of livestock and zoonoses globally, and at the building of a global SRA. To get to a common SRA, foresight studies were collected worldwide, where available, or initiated.

Foresight can be defined as “a process by which one comes to a full understanding of the forces shaping the long-term future which should be taken into account in policy formulation, planning and decision-making” (Coates 1985). Foresights are increasingly used for both short and long term research and development planning in several fields, supporting a more effective decision making process (Brummer *et al.*, 2008, Könnölä and Haegeman 2012). The inclusion of foresights in the framework of ERA-Nets has been shown to support the overcoming of possible barriers, supporting priority setting, and sustaining the definition of a shared vision (Brummer *et al.* 2008). These effects appeared to be even more marked when these methodologies are applied to transnational programming (Könnölä and Haegeman 2012).

The described framework inspired the Italian Ministry of Health to launch the FORE-Med (Foresight project for the Mediterranean area) study. The objectives of FORE-Med were to define research priorities on livestock health for the Mediterranean area as a whole, and to update and define in more details the research needs identified by the EMIDA SRA for Mediterranean, including the South-Eastern

area of the basin, as well as widening the scope to production diseases and aquaculture. The goal of this paper is to present the developmental process and main outcomes of the FORE-Med exercise.

Materials and methods

The FORE-Med study was developed following 3 main phases:

- analysis of the current situation;
- formulation of probable future scenarios;
- implementing of strategic choices.

While several possible approaches to foresight exist, these 3 phases are recognised in all studies. As for the methods to be implemented in each phase, the foresight ‘toolbox’ is modular and the facilitators should select the most suitable method for the given study, according to time and resources constraints (Durance and Godet 2010). While increasing the number of methods is not necessarily beneficial to the outcomes of the process, the selection of the appropriate methods covers a role of paramount importance (Popper 2008). Thus, for each of the selected phases, the most appropriate methods (outlined in Figure 1) were selected through *ad hoc* review of the available literature and scaled by previous relevant foresight studies.

Analysis of current situation

For the purpose of this study, for ‘animal health’ we intend both infectious and non-infectious diseases

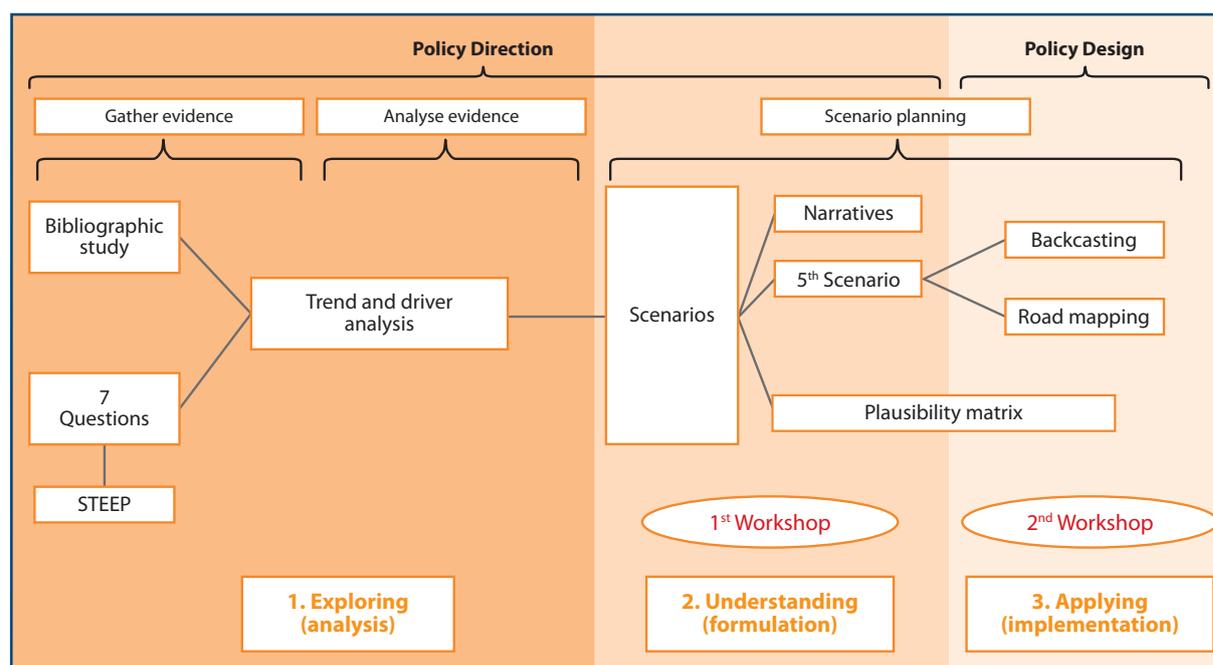


Figure 1. Breakdown of the techniques implemented in the FORE-Med study (adapted from Bhimji 2009).

of farm animals, including fish in aquaculture, and including those conditions posing a threat to human health, with the exception of food safety issues relating to livestock products. Wildlife diseases were not considered, except where they act as reservoirs of infection for humans or production animals.

Before developing future strategies for animal health research in the Mediterranean, it was fundamental to explore the current situation, analysing the trends in the sector and the forces (drivers) moving them. To this end we deployed a multi-step approach, involving a selected group of experts and stakeholders.

Firstly, evidences were gathered to identify drivers. Drivers can be classified in 2 main categories: micro-environmental drivers, being specific forces acting on the animal health sector and having a direct influence on it (e.g. infectious disease evolution); and macro-environmental drivers, being broader and more global forces impacting the sector indirectly (e.g. social, economic or environmental factors) (Horizon Scanning Centre 2008). A bibliographic research to identify existing drivers on animal health, also scaling them from other areas, was performed. A group of key experts was selected from the main fields of the STEEP (Social, Technological, Economic, Environmental, and Political) analysis, to which animal health was added to refine the study on future perspective in this sector. Then, interviews were carried out through the '7 questions' methodology, in order to adapt the identified drivers to the Mediterranean area. This technique consists of in-depth, one-on-one interviews conducted using a series of open questions having just-enough structure and being framed as to encourage respondents to look beyond current technology or economic situation, allowing them to identify the issues that they see as important (Amara and

Lipinsky 1983). These questions can be structured in different ways, depending on the aim of the survey, and permit to highlight contextualised information about the study area from different sectors in an effective and fast way. The information and insights gained from these interviews are much richer than what would be obtained through group interviews, since the involvement of each participants is higher and they are normally eager speaking about the future in their own sector, since it is linked to their own professional future (Nyewe 2011).

The specialists were selected based on their expertise and contacted by the project coordinator to agree on a suitable date and hour for the interview to be carried out. This approach permitted to ensure the complete availability of the expert for a given time, avoiding time pressure and allowing for a better state of mind during the interview. Face to face or videoconference interviews were chosen depending on the circumstances and with the goal of obtaining a positive cost-benefit solution. This permitted to interview experts in different countries across the Mediterranean, while containing travelling costs and time.

The questions, similar to the ones used in others foresight studies carried for the STAR-IDAZ project, were structured in order to allow the interview to last between 40 and 80 minutes. The content of the questions is reported in Table I. In order to facilitate the free expression of the experts, it was decided to guarantee the anonymity of the full interview contents.

The aim of this survey was to reduce the number of initially identified drivers, to get to 5-10 key drivers, to be used in the following phases of the project.

The next phase consisted in the analysis of the identified drivers to support next step of the project, namely the scenario building. This latter

Table I. Seven questions used for the phone interviews to experts in the social, technological, economic, environmental, political and animal health sector in the Mediterranean area.

1) Past changes	Thinking back over the past 10-15 years, what changes in your sector have affected animal health in the Mediterranean area (and globally)? What has changed and what drove those changes?
2) Lessons from the past	Reflecting on past changes, what have been the big 'successes' in animal health? Are there lessons to be learned? Are there things we need 'to forget'?
3) Current constraints	What things need to be changed in your sector for the animal health system to be successful in the future? Are there barriers to innovation and change that need to be addressed?
4) Challenges	Are there near-term external challenges in your sector facing animal health that could have significant impact on longer-term outcomes?
5) Dark spot	There is a dark spot on the horizon. It is not here now but could have a major impact on animal health in the Mediterranean area in the future. What is it?
6) Good future	Suppose you were looking back 10-12 years from now and you were telling a story in which the animal health management system had done extremely well. How would the story go? What does a good future look like? What societal developments are needed for that good future to occur?
7) Oracle	The future is unknown, but suppose you could ask two questions to an oracle who could predict the future, what would you ask about animal health sector?

consists of the construction and use of more or less systematic and internally consistent visions of plausible future states (Popper 2008). In order to ease the scenario building, it was decided to choose 2 main drivers among the selected ones. The two drivers were used as the Cartesian axis on which the future scenarios would be defined and the other drivers would be positioned. The criteria for the selection of the 2 drivers were high relevance and high variability. However, all other drivers would have been considered in the scenario development, in order to ensure the maximum possible degree of completeness and cohesion of the described stories.

The selection of the 2 main drivers was performed through expert elicitation. In this phase, to avoid the expert group to be dominated by shared knowledge or over-strong opinions, it was decided to elicit opinion via written questionnaires, in order to prevent any interaction among the participants (Cox *et al.* 2012). Moreover, since this primary phase should involve the greatest possible number of people (Durance and Godet 2010), it was decided to develop an on-line survey, so to reach a high number of target recipients, while limiting the spending of resource. The questionnaire was developed using the SurveyMonkey® software and consisted of 2 questions. In the first one, the respondents were asked to provide a score, on a 1 to 7 scale, about the relevance of the given set of key drivers (as identified during the '7 questions' phase). The second question asked to express, using again a 1-7 scale, an opinion about each driver uncertainty. It was decided to use numerical scales, not having any descriptor associated to the numbers, since previous studies already highlighted that individuals prefer to use numerical responses when assessing aleatory uncertainties (Olson and Budescu 1997), such as the ones presented in the present study. The survey was disseminated to 133 relevant experts, distributed all over the Mediterranean basin. The participants were selected from 3 databases, including experts belonging to the most active international organisation (e.g. OIE, FAO, and EFSA), the national reference centres, and laboratories in the area. Based on the received replies, the 2 main drivers were selected.

Formulation of probable future scenarios

The building of plausible scenarios is 1 of the methods most frequently used in foresight exercises in development and innovation fields. In fact, even though scenarios are not a requisite part of strategic foresight, they have proved to be effective in clarifying the consequences of current decisions, hence supporting decision-making (Durance and

Godet 2010). A scenario is a 'story' about how the future would possibly unfold, affecting the area of interest. To be considered a proper scenario, the 'story' must fulfil 5 conditions: pertinence, coherence, likelihood, importance, and transparency (Durance and Godet 2010). The aim of the scenarios' formulation is to stimulate imagination and deep thinking on a process, helping foresight and enhancing future preparedness.

Scenario building was performed through a dedicated workshop. Workshops present several advantages in this phase of foresight studies: in addition to allow for the gathering of important preliminary data, they serve to introduce the methods of strategic foresight to the participants, and to get them used to working together, which is important to ensure the success of the foresight process (Durance and Godet 2010). Furthermore, the active participation of the experts in the foresight exercise is fundamental to heighten their sense of ownership of the outcomes and their desire for continued involvement (Robinson *et al.* 2011), both being requisites for the adoption of the strategic choices emerging from the study.

The first workshop took place in Rome, over 2 days, in March 2014. A think-tank of 44 experts, coming from different areas of the Mediterranean, was selected, involving specialists belonging to various sectors, such as veterinary sciences, epidemiology, climatology, agriculture sciences, and environment. Although the number of scenarios in foresight studies might be broad, it is advisable to limit it to 4 to 6 key hypotheses (Durance and Godet 2010). The 2 selected drivers were used as Cartesian axis for the building of 4 scenarios on the Mediterranean basin in 2030. The Cartesian plane was represented by 4 quadrants, each being defined by a combination of high/low variability of each of the 2 identified drivers.

On the first day of the workshop, the participants were divided in 4 working groups, each having balanced expertise and being guided by a facilitator, and a scenario was randomly assigned to each of them. The task of each group was to describe which extreme situation could happen within the 2 two given trends (i.e. stability vs. variability) of the key drivers, which were the peculiar aspects of the 4 different scenarios. In particular, the participants were asked to:

- define a short and highly descriptive title for the given scenario;
- develop a scenario description comprehensive of a narration of the events, decisions and choices that led from the present to that future in 2030;
- briefly describe a list of the drivers that intervened and the logic behind them.

The 'plausibility matrix' is a tool to help groups familiarising with an existing set of scenarios, exploring differences of opinion, and highlighting the strategic choices that need to be made to ensure that policies or strategies are fit for the future (Horizon Scanning Centre 2008). A 'plausibility matrix' was provided to each group to help them extract plausible and favourable factors from their scenarios. The matrix, filled with the inputs of the 4 groups, was discussed in a plenary session, in order to provide all participants with a full overview of all scenarios and to stimulate discussion.

On the second day of the workshop, a fifth scenario was defined, merging the inputs coming from the plausibility matrix and from the plenary discussion. This last scenario represented the 'preferred future': a future that, while being plausible, contains positive aspects concerning the investigated fields (e.g. where the weaknesses of the sector are successfully mitigated).

Implementation of strategic choices

The third objective of a foresight project aims at defining the strategies to be implemented to reach the preferred future. In this study, the back casting method was applied. This method consists of starting from a desirable and plausible future and working backwards to the present time, in order to strategize and plan how the desired future could be achieved (Quist and Vergragt 2011). The aim of this phase was to identify intervention strategies to be implemented in the field of research on animal health (both production and infectious diseases) and aquaculture, that would permit to achieve the desired future (fifth scenario).

The back casting exercise was carried out during a second two-day workshop, which took place in Rome in November 2014. Differently from the first workshop, where the range of expertise was broader, in this case all experts belonged to the animal health research fields. In fact, while a broader range of expertise was needed to select the macro-areas of investigation and to shape a preferred scenario as inclusive as possible of all the different aspects; at this stage of the project an in-depth knowledge of the research areas was needed, in order to identify up to dated and detailed research needs. Workshop participants were selected on the basis of their expertise. In addition, other criteria were considered to balance groups more accurately (e.g. age, gender, institutional affiliation), as suggested by Rasmussen and colleagues (Rasmussen *et al.* 2010). A trade-off between researchers and policy-makers/funders was ensured as well.

The back casting process involves considering barriers and enablers to the preferred future, in

order to identify possible pathways to meet the vision. In view of the differences existing among the countries in the area, which made it likely that different enablers and barriers were present in the region, it was decided to subdivide the region into 2 sub-areas, mapping the geo-political situation. The Northern area included the countries belonging to the EU and to the Balkan area, while the Southeastern one included the remaining Mediterranean countries. The workshop delegates were split into the 2 geographical sub-groups for this exercise. In order to ensure harmonisation between the works of the 2 groups, some guidelines were provided to the participants and facilitators were present in each group. The subgroups were asked to define what elements were different between the given future and today situation in the given sub-area, and to identify the barriers to the achievement of the preferred future (as well as the enablers that could contribute in tearing down/reducing the extent of such barriers). In addition, delegates were asked to identify the strategies, or 'pathways of action', to mitigate the impact of the barriers and to help enhancing the effect of the enablers.

During the morning of the second day, the outcomes of the 2 groups were discussed in plenary. The lists of identified barriers and enablers were merged and each group was asked to attribute a scoring 1-5 to each of the items (for both sub-areas), looking at them from a sub-regional perspective. The most relevant barriers and enablers were identified for the Mediterranean sub-regions and an average score was calculated for the area as a whole. In addition, experts were asked to define whether each of the identified enabler/barrier was under control (i.e. whether the actions performed by the expert groups, or by other having their professional role across the countries, could affect it) or not. In case of disagreement between the 2 sub-groups about the assessment, consensus was reached discussing the issue in plenary, asking the expert to refer to the Mediterranean as a whole.

The remaining part of the second day of the workshop was fully dedicated to research prioritisation. The proposed exercise was designed to specifically target the prioritisation of the identified research topics, and the proposal of a time of intervention for the different areas.

The participants were divided into 3 sub-groups, 2 for terrestrial animals and 1 for aquaculture. While for terrestrial animals it was decided to keep the participants divided into the 2 geographical sub-regions, the expert group for aquaculture included experts from both Northern and South eastern countries, in order to allow for the definition of a regional perspective on the issue.

Each group was asked to identify the main research

areas and topics to be used as a basis for the prioritisation exercise, taking also into consideration the identified enablers and barriers, and amend the list if need be. The terrestrial animal groups were asked to provide separate prioritisation lists for infectious diseases and production ones, while these were merged in the aquaculture group.

Four main tasks were given to the experts for the implementation of the exercise:

- to weight animal health research area with the identified criteria;
- to define priorities of the selected research area;
- to identify specific topics or intervention area for each research area for both terrestrial animal/ aquaculture;
- to define a time of intervention ('urgency of intervention') for the given research topics.

A 3-point scale was provided for the weighing of the research topics ('High', 'Medium', and 'Low'). Lastly, experts were asked to define a preferable time for the intervention on the selected research topic, this being either 'Short-medium' or 'Long'.

Results

Sample characteristics

Overall, 100 experts with various backgrounds participated in the study. In order to ensure a regional perspective, experts from 11 countries around the Mediterranean basin were gathered (Croatia, France, Greece, Israel, Italy, Lebanon, Malta, Morocco, Spain, Tunisia, and Turkey). One hundred and thirty-three experts were invited to participate in the survey, among which 75 completed the questionnaire (56%). Forty-four experts attended to the first workshop, and 39 to the second one. Although some experts participated in more than 1 of the project phases, different experts were invited in the different phases of the study, in order to strike a tailored expertise and geographical balance.

Group were balanced to encompass experts with different numbers of years of working experience and gender, as well as expertise, i.e. a trade-off between researchers and policy makers/funders was ensured (Table II).

The main areas of expertise of the participants are reported in Table III. The expertise list provided by Wentholt and colleagues (Wentholt *et al.* 2012) was used albeit some with slight modifications made to broaden the scope so to include production diseases and aquaculture. A main area of expertise was identified for each expert. When appropriate,

Table II. Distribution of the experts (%) per working experience, gender and type of belonging institutions.

Characteristics		Distribution (%)
Years of working experience	5-15	49
	Over 15	51
Gender	Male	64
	Female	36
Belonging institutions	Research centres	64
	Governmental institutions/ policy advising	36

Table III. Sample characteristics. Main and additional expertise of the involved participants. Each expert has one main expertise and could have one or more additional ones.

Expertise	Main	Additional
Animal diseases	9	18
Epidemiology	7	11
Risk analysis	3	13
Bacteriology	12	8
Virology	11	5
Public health	8	13
Parasitology	6	1
Production diseases	10	7
Fish health/Aquaculture	7	1
Agriculture	10	3
Research management	10	8
Other ^a	7	13

^aOther, including: Agro-economy, Animal genetics, Animal welfare, Communication, Immunology/Vaccinology, Meteorology/Climate, Risk communication, Risk management, Sociology, Wildlife.

based on the skills and background of each expert, additional area(s) of expertise were also added.

Analysis of the current situation

The various methods (i.e. bibliographic study, STEEP, 7 questions, and trend and driver analysis) implemented to analyse the current situation allowed for the identification of 9 key drivers acting on animal health in the Mediterranean area, which are listed below:

- infectious diseases evolution;
- economics and trade patterns;
- demography evolution;
- social values changes;
- advances in communication;
- environmental changes;
- political/leadership evolution;

8. technological advances and challenges;
9. production system changes.

The list of identified drivers was sent to all of the experts involved in the on-line survey. The averages for both relevance and variability scores were calculated and added up for each of the selected drivers, in order to identify the 2 drivers being both the most relevant and uncertain (Table IV). Infectious diseases evolution (10.34) and Environmental changes (10.01) emerged as the main drivers in the given context.

Formulation of probable future scenarios

The 2 drivers constituted the orthogonal axes for the Cartesian plan, which included the 4 scenarios (1 for each quadrant, Figure 2). The key drivers were considered as the main influencers of the scenarios, while all other drivers, as well as the events in the scenario description, were to be made consistent with them. A quadrant was assigned to each one of the 4 groups to draw a scenario for which they provided a title, explicative of the scenario contents, and a narrative describing it in details.

The 4 scenarios have the following main features:

Scenario 1: 'Everything needs to change to keep everything unchanged' foresees the levelling of economics between Northern and South-Eastern area of the basin; an increase of the socio-political stability and of trade flows (including for animal and animal products); an increase of cooperation and joint activities (including animal health surveillance) in the area.

Table IV. Sum of the average relevance and variability score of the key drivers (ranking scale for each being 0-7).

Key drivers	Average relevance score	Average variability score	Sum of average relevance and variability scores
Infectious diseases evolution	5.93	4.41	10.34
Economics and trade patterns	5.41	4.23	9.64
Demography evolution	4.47	3.61	8.08
Social values changes	4.38	3.93	8.31
Advances in communication	4.38	3.58	7.96
Environmental changes	5.41	4.60	10.01
Political/Leadership evolution	4.53	4.73	9.26
Technological advances and challenges	5.27	3.70	8.97
Production system change	4.97	3.76	8.73

Scenario 2: 'At sight navigation in the Mediterranean Di-seas' describes major socio-political and economic instability in the area, which makes long-term planning hard (including for animal health). It also considers a possible increasing of migration and trade flows as well as growing occurrence of infectious diseases (including zoonoses).

Scenario 3: 'Einstein theory' suggests that the climate disruption in the area causes a shift in the insect population, new pests enter in the area while pollinators decrease, posing serious risk to agriculture (including farming) and making necessary to increase food import. The economic and political crisis, exacerbated by this situation, undermines research and animal health surveillance, with dramatic consequences for animal and public health.

Scenario 4: 'Don't worry, be aware!' suggests that extreme climate changes occurs in the area, impairing farming, while the industrial sector flourishes, sustaining the economy and supporting equilibrium in the area. There is a drive toward food with high technological input (e.g. genetically modified organisms) and the technological advances facilitate the control of animal health.

Each group extracted, from the given scenario, a list of plausible drivers (i.e. drivers present in the scenario and which are most likely to be present in the real future thus affecting, either positively or negatively, animal health) and favourable drivers (i.e. drivers present in the scenario, which, if present in the future, would favour the improvement of animal health) for animal health for Mediterranean 2030. These were aggregated and compiled in a list of 22 plausible and 17 favourable drivers, which are reported in Table V.

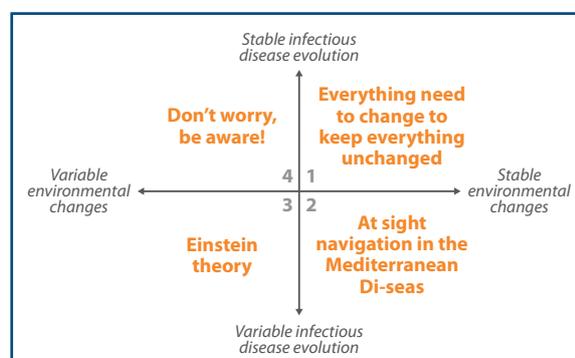


Figure 2. FORE-Med scenarios. Each quadrant of the Cartesian plan, being described by a coordination of a different trend for one of the two main drivers (Infectious disease evolution and Environmental changes), constitutes the basis for one of the four scenarios. The title assigned to each scenario is provided in orange.

Table V. List of plausible and favourable drivers for animal health for Mediterranean 2030.

Plausible	Favourable
Breeding for genetic resistance	Change of trade flow
Change in trade pattern	Coordination of surveillance
Development of new therapeutics to contrast drug resistance	Development of short commercial chain
Diffusion of new ways of communication (social networking)	Development of sustainable policies
Effective knowledge transfer at all levels	Implementation of a long term political vision
Globalisation	Implementation of animal identification system by genomic
Illegal immigration	Implementation of political decision supported by scientific information
Implementation of a common and integrated animal identification systems	Implementation of risk-based decision
Implementation of multidisciplinary approach in the veterinary field	Implementation of the One Health approach
Increase food safety awareness	Improved communication strategy
Increase in migration patterns	Increase in informatics tools availability
Increase in population size	Increase of disease prevention through affordable and efficient vaccine
Increase in raw materials prices	Increase of education level
Increase in surveillance activities	Increase of farming economics (sustainability/profitability)
Increased attitudes to new technology	Increased food safety awareness
Increased migration patterns	Institutional response to communication patterns
Industrialisation	Positive attitude to new technology
Intensification of animal production	
Networking for sharing skill and diagnostic knowledge among laboratories	
Political instability	
Set up of a strategic agenda for Mediterranean countries	
Urbanisation	

This list was presented on the morning of the second day of the workshop and served as a basis for starting the plenary discussion. During the discussion, all participants agreed on the description of the fifth scenario for a plausible and favourable Mediterranean in the 2030.

Implementing of strategic choices

The plausibility matrix and back casting allowed for the identification of several barriers and enablers, which were prioritised by each group and ranked in plenary during the second day of the workshop. Table VI and VII present the highest-ranking barrier and enablers respectively (i.e. all items having received an average score, in both geographical areas, of 4 to 5).

Several priority research areas for animal health in the Mediterranean region were identified during the workshop, both on terrestrial animal infectious and production disease and aquaculture. Common research topics emerged from the sub-regional working groups. The ones being ranked as either 'High' or 'Medium' priority by both sub-regional groups and all of those being ranked either 'High' or 'Medium' by the aquaculture group are presented in Table VIII. An indication of the timetable for developing the identified research topics was also

agreed, being short (up to five years), medium (five to ten years) or long (more than ten years).

Discussion

Several studies have been conducted already in an attempt to prioritise research efforts on infectious diseases in several countries. Nevertheless, such

Table VI. Main barriers to the achievement of the fifth scenario for Mediterranean 2030 according to the average score between the two geographical sub-groups (ranking scale for each being 0-5). Barriers out of control are coloured in grey.

Barriers	Relevance
Water pollution	5
Climatic changes	4.5
Economic crisis	4.5
Competition between funders, overlap of research and waste of financial resources	4
Cost of disease control tools	4
Cultural, political, religious differences	4
Lack of support to agriculture	4
Low quality of research	4
Social inequalities	4
Vaccine licensing process (i.e. duration and complexity)	4
Water competition	4

Table VII. Main enablers to the achievement of the fifth scenario for Mediterranean 2030 according to the average score between the two geographical sub-groups (ranking scale for each being 0-5). Enablers out of control are coloured in grey.

Enablers	Relevance
Availability of effective vaccines	5
Harmonisation and networking among veterinary services (VS) of neighbouring countries	5
Data sharing	5
Resources availability	5
Data quality	4.5
Development of expert networks	4.5
Education for citizens and stakeholders	4.5
Improvement of technology	4.5
Standardisation of disease control tools production/ research/test validation	4.5
Study on natural resistance	4.5
Traceability	4.5
Validated diagnostic methods	4.5
Appropriate regulations (e.g. for the licensing of drugs, surveillance, trade control)	4
Development of water reuse systems	4
Encouraging the one health approach	4
Increase investment in 'fundamental' research	4
Increase study /research in 'other' animal species (e.g. camels, wildlife, pests)	4
Investments in genetic selection	4
Maintenance of the genetic biodiversity	4
Production and distribution of reference materials	4
Regionalisation of the approach (e.g. communication, control posts, vaccination strategies)	4

studies are only useful in the context in which they are conducted and, due to the variability of several factors involved in the process, updates need to be performed periodically (Krause 2008). The FORE-Med project represents the first structured attempt to build a common strategy to face future research challenges on livestock health at Mediterranean level.

A rather large number of experts (100 overall) participated in the study, providing a substantial sample size. This, together with the selection of individuals having various backgrounds and origins, should guarantee a mitigation of possible bias due to experts providing opinions reflecting the perspectives of one particular sector or country (Cox *et al.* 2012). As it happened already in the experience of described by Wentholt and colleagues (Wentholt *et al.* 2012) on a similar topic (i.e. emerging infectious animal diseases), most participants had animal disease and veterinary medicine background, which appears appropriate for this kind of study, despite the sampling frame focused on multiple areas of expertise. The changes performed in the expert

group composition between the 2 workshops would have further reduced possible bias due to group composition (Jones and Hunter 1995). The inputs of the various experts were not weighted according to the sector or years of experience in the area, since previous experiences proven this approach either difficult to assess it (i.e. experts having multiple background) or having a minor impact on the overall conclusions (Cox *et al.* 2012). The panel of experts who participated in this project was deemed appropriate for the study purpose. Nevertheless, the allocation of a dedicated budget to foresight exercises could help in a more proficient involvement of experts coming from different areas, representing an added value to the results. Several countries, such as the USA and the UK, already provide their own governmental institutions organisation with dedicated foresight units. Due to the relevance of the topic, and to the possible impact on the population, a similar approach might be advised also for the animal health field in the Mediterranean area.

The method encountered a high level of appreciation across the scientific community involved in the study. Despite the novelty of the approach, the experts found the process appealing and were able to follow it profitably. The active participation of the experts in foresight exercises is of paramount importance to increase their sense of ownership of the results and desire for continued involvement (Robinson *et al.* 2011). For this purpose, the use of workshops was decided in order to stimulate team-working and to provide participants with an immersive introduction to the work ahead (Durance and Godet 2010). These participative exercises are also a social learning occasion, as they stimulate participants to argument their own positions, to reconsider them critically and, eventually, to revise them following a debate and pair confrontation. In particular, learning processes stimulated by participative experiences might concern not only solutions to a given problem, but also a redefinition of the problem itself (Genus 2006). Lastly, foresight can represent an optimal network building processes, encouraging communication, collaboration, and opinion exchange among experts coming from different organisations, sectors and between private and public bodies (Becker 2002). The network that was created during the FORE-Med project, bringing together animal health experts from the whole Mediterranean area, is in itself an important added value within the framework of building a common pathway toward the coordination of the research in the area. In addition, this project allowed the experts (including the research project owners and funders) to share a common strategic vision, and to have a sense of commitment toward it. This might represent an

Table VIII. Priority research areas identified for infectious and production diseases of terrestrial animals and aquaculture. Relevance scoring 1 indicates higher priority (High ranking in both sub-regions), 2 an intermediate priority (High ranking in one region and Medium in the second one) and 3 a lower priority (Medium ranking in both sub-regions). Time of intervention is as follows: S (short, up to 5 years), M (medium, 5 to 10 years) L (long, more than 10 years).

Research topic	Category	Relevance	Time of intervention
Definition and application of effective and harmonised control measures in all countries of the area	Infectious diseases	1	S
Study on antimicrobial (and anti-helminthic) reduction strategies	Production diseases	1	S
Identification of fish welfare indicators in traditional and organic farms	Aquaculture	1	S
Improve the monitoring about enteric viruses in bivalves farmed in lagoon and off-shore	Aquaculture	1	S
Investigation on presence of zoonotic parasites in farmed fish according to EFSA opinion	Aquaculture	1	S
Study on the verification of the efficacy of vaccines	Aquaculture	1	S
Development of a laboratory network for information and technology exchange	Infectious diseases	1	M
Development of new vaccines (e.g. DIVA, recombinants)	Infectious diseases	1	M
Implementation of control and monitoring on vectors, also using new products	Infectious diseases	1	M
Development of a Mediterranean traceability system to exchange data	Aquaculture	1	L
Development of new vaccines for new diseases	Aquaculture	1	L
Harmonisation of diagnostic analysis	Aquaculture	1	L
Monitoring of the mortality of wild fish and shellfish.	Aquaculture	1	L
Establishment of a network with human medicine	Infectious diseases	2	S
Implementation of economic evaluation of interventions, to obtain sustainability	Infectious diseases	2	S
Development of knowledge management systems allowing sharing and exchange of data	Infectious diseases	2	M
Development of whole technology for rapid production and use of vaccines (e.g. antigen banks)	Infectious diseases	2	M
Implementation of training and education with multidisciplinary approach	Infectious diseases	2	M
Development of animal and product identification and registration systems	Infectious diseases	2	L
Evaluation of gut health using new feed sources	Production disease	2	L
Study on strategies to manage the impact of intensive farming	Production disease	2	L
Development of legal framework to improve disease surveillance	Aquaculture	3	S
Study on anti-parasite drugs	Aquaculture	3	S
Study on atypical mycobacteriosis	Aquaculture	3	S
Study on farmed fish technopathy	Aquaculture	3	S
Study on new feed sources	Aquaculture	3	S
Study on parasitosis on fish bred in sea cages	Aquaculture	3	S
Study on photo-bacteriosis in marine fish	Aquaculture	3	S
Development of robust and cheap field tests (pre-screening)	Infectious diseases	3	M
Development of re-utilisation systems for slurries and water recycling	Production disease	3	M
Development of prebiotics and herbal stimulants to improve a-specific immunity system	Aquaculture	3	L
Development of sustainable therapies	Aquaculture	3	L

important driver in supporting the adoption of the recommendations derived from the FORE-Med.

The process allowed for the identification of priority research areas and topics in the field of animal health, which will constitute the basis for the first Mediterranean Strategic Research Agenda. The provision of indication for a temporal scale for the intervention will permit to define a path to the preferred future, if the identified actions will be implemented.

The proposed approach represented an innovation in the field of prioritisation studies on animal health, which usually focus on specific diseases (DISCONTTOOLS 2012, McFadden *et al.* 2015) rather than on multidisciplinary aspects. That is why, despite

the fact that the study was on animal health, some research topics were identified out of the traditional veterinary area (e.g. economics of interventions, information technology systems, and networking activities). Indeed, all the involved experts deemed the development of multidisciplinary research topics and the merging expertise in different fields increasingly more important, as observed by Wentholt and colleagues (Wentholt *et al.* 2012).

Interestingly, several of the urgent top priority research topics identified are not 'research topics' *sensu stricto*, but rather needs for re-organisation or re-shaping of the veterinary system. This suggests that the experts recognised that research, if not properly integrated in an effective system, would

not suffice to guarantee the meeting of the goal of the preferred future. A similar situation emerged from the EMIDA project, supporting the robustness of the outcomes of the present study (Wentholt *et al.* 2012).

The provided indications regard both terrestrial and aquatic animals, and encompass animal health topics considered from a broad perspective, including both infectious and production diseases. Although animal welfare is somewhat mentioned among the topics, it was not 1 of the targets of the initiative, and it should be considered as a component of animal health for the purpose of the FORE-Med project. This may imply that relevant aspects concerning animal welfare could not be included among the listed priorities.

The collected information represents a huge opportunity for both national government and international organisation, as well as for other stakeholders, to tailor animal health policies toward a proactive rather than reactive approach, being able to allocate funding more efficiently and decide over intervention strategies to get to timely solution of future animal health issues.

Conclusions

FORE-Med confirmed that foresights are effective in reaching the aim of integrating transnational

research planning, also in the field of animal health. This exercise proved useful to overcome the institutional barriers and sustaining the definition of a shared vision on the future research among stakeholders in the field under study. Furthermore, it improved communication among different organisations, which could expand their views through a mutual learning process. Lastly, the identification of research topics through a scientific methodology and expert think-tanks is more likely to be well received by policy-makers and funders, hence improving their availability on funding research on the areas. For this reason, the allocation of a dedicated budget to implement foresight exercises to keep stakeholders updated on the different needs that could arise in a changing environment would be of great help to sustain an effective and efficient decision-making process.

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