HOW EXTERNAL FACTORS
(e.g. climate change, conflicts, socio-economics, trading patterns)
WILL IMPACT VETERINARY SERVICES AND THE ADAPTATIONS REQUIRED

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Summary: This Technical Item addressed the question of how External Factors (e.g. climate change, conflicts, socio-economics, trading patterns) will impact Veterinary Services over the next ten years and the Adaptations required. Information gathering centred on a questionnaire sent to OIE Member Countries but included expert elicitation, a scenario-building workshop, and a complementary questionnaire send to external stakeholders. The response rate to the OIE Member Country Questionnaire was high (74%) and balanced across OIE regions and income categories.

A long-list of 59 External Factors highly relevant to Veterinary Services was developed through a structured Expert Survey. The most relevant 17 External Factors were evaluated by OIE Member Countries and Stakeholders. There was overall high level of concern over External Factors, good levels of knowledge, less current activities (Adaptation) and even less activities oriented towards future change (Preparedness). The high agreement of OIE Member Countries with Stakeholders supports the external validity of these assessments.

Both OIE Member Countries and Stakeholders judged Veterinary Services to have appropriate priorities, high levels of capacity, and strong influence; both groups of respondents also see opportunities to further strengthen these. Through scenario planning, a preferred future 'Green Growth with Equity' was identified along with suggestions for what Veterinary Services could do to help bring this about.

OIE Member Countries reported on the current future-oriented activities of Veterinary Services, showing overall high engagement in general planning and disease and health risk assessments, but less use of institutional risk assessment or formal Foresight studies. However, they assessed these as highly important for Veterinary Services, thus implicating a gap which needs to be overcome so that Veterinary Services can be best prepared for an uncertain future. OIE Member Countries identified and ranked actions that could support the capacity of Veterinary Services for Foresight and Adaptation, including areas which the OIE would lead.

Keywords: climate change – external factor – foresight – Veterinary Services.

1. Introduction

At the 85th General Session of the OIE held in Paris in May 2017, the World Assembly of National Delegates to the OIE confirmed that the Technical Item with questionnaire that would to be presented during the 87th General Session of the OIE in May 2019 would be '*How External Factors (e.g. climate change, conflicts, socio-economics, trading patterns) will impact Veterinary Services, and the Adaptations required*'. The OIE set a time horizon of ten years, the scope was global, and External Factors were broadly interpreted, but with a focus on climate change.

The OIE defines Veterinary Services as the governmental and non-governmental organisations that implement animal health and welfare measures and other standards and recommendations in the OIE's *Terrestrial Animal Health Code* and *Aquatic Animal Health Code* under the overall control and direction of the Veterinary Authority. Private sector organisations, veterinarians, veterinary paraprofessionals or aquatic animal health professionals are normally accredited or approved by the Veterinary Authority to deliver the delegated functions.

Veterinary Services play a fundamental role and contribute to economic, environmental and social dimensions of sustainable development of their countries and to achievement of the 2030 Agenda for Sustainable Development. As such, it is important that they can understand, adapt to and influence External Factors.

Policy seeks to anticipate and also influence the future and, as policy makers, national Veterinary Services have an important role in anticipating and influencing the future of their countries and the world. Foresight is a systematic, participatory and multi-disciplinary approach to explore mid- to long-term futures and is hence useful for orienting the Technical Item.

Hence, the objectives of this Technical Item were: a) to better understand External Factors likely to influence national Veterinary Services' performance, mandate and ability to contribute to sustainable development; b) to assess capacity of Veterinary Services to adapt to and influence External Factors and to manage the associated threats and opportunities; and, c) to identify Veterinary Services' capacity needs and how the OIE can best support its Members in the face of External Factors, especially climate change. The scope was global, differentiated by OIE region and the timeframe under consideration was the next decade (up to 2030).

2. Methods and Questionnaire

The Technical Item was developed as follows.

- *Conceptual framework and approach*: We first reviewed available literature and identified a framework to organise External Factors relevant to Veterinary Services and weigh their positives and negatives (Bishop & Hines, 2012). The methods for collecting information were drawn from the Futures Toolkit (GO- Science, 2017) and the United Nations Development Programme's Foresight Manual (2018).

- *Expert survey*: Identifying 'what is driving future change' is central to understanding where the future of the domain is heading. We developed a long-list of External Factors based on the literature. We then identified 49 experts who we considered knowledgeable about both Veterinary Services and Foresight and asked them to assess External Factors along two dimensions of impact: general importance to society and specific importance to Veterinary Services. The top 17 External Factors were then used in the OIE Member Country and Stakeholders questionnaires as the key External Factors to be evaluated. Additional questions on External Factors related to climate change were added.

- *Forecast and future scenarios*: Scenarios are stories that describe alternative ways the external environment might develop in the future. Scenarios are not predictions, but tools to help in planning and understanding preparedness for the future. The study team developed four scenarios: 'Business as Usual', 'Preferred Future' and two 'Alternate Futures'.

- *OIE Member Country questionnaire*: This was the central tool for gathering information. It was designed with the following four sections: current Foresight activities; External Factors; scenario analysis; support needed.

- *OIE Stakeholder questionnaire*: External participants bring essential perspectives to Foresight studies. We developed a similar, but shorter version of the questionnaire which asked OIE Stakeholders to give their opinion on how External Factors would affect Veterinary Services and the Adaptations required. This was sent to a range of OIE Stakeholders, including institutes with whom OIE has an official agreement, OIE Reference Laboratories, OIE Collaborating Centres and individual experts.

3. Responses to the Questionnaires

Expert Survey: Overall, 21 experts responded to the Expert Survey to assess the importance of 59 External Factors. Experts were asked which global regions they were familiar with; they could select multiple regions.

OIE Member Country questionnaire: Of the 182 OIE Member Countries to which the questionnaire was sent, 134 (74%) answered at least one question and 125 (69%) answered all the questions. Response rates varied by OIE region: among those who answered at least the first question, it was highest in the Americas (87%), followed by Asa, Far East and Oceania (81%), then Europe (75%), then Middle East (71%) and Africa (65%). **Annex 1** includes the responding countries classified by OIE region.

OIE Stakeholder questionnaire: In all, 106 responses were obtained from OIE Stakeholders. Most Stakeholder respondents (85%) interact weekly or monthly with Veterinary Services. Responding Stakeholders were currently located in Europe (54%), followed by the Americas (22%), Asia, the Far East and Oceania (22%), Africa (6%) and the Middle East (1%).

4. External Factors

4.1. Identifying External Factors relevant to the Veterinary Services through an Expert Survey

To systematically develop a manageable list of External Factors, we conducted an Expert Survey of people familiar with Foresight and Veterinary Services. They assessed 59 External Factors, which included trends (a general tendency or direction of a process over time), and shocks (a discontinuity or sudden, major change). Experts considered shocks were more important to society but trends more important to Veterinary Services. No individual shock was considered very likely, but 12 shocks were considered likely. Unsurprisingly, trends were considered more likely to continue.

Experts saw health and social External Factors as most important to Veterinary Services and geo-political, economic and environmental External Factors being as more important to wider society but relatively less important to Veterinary Services (**Fig. 1**).
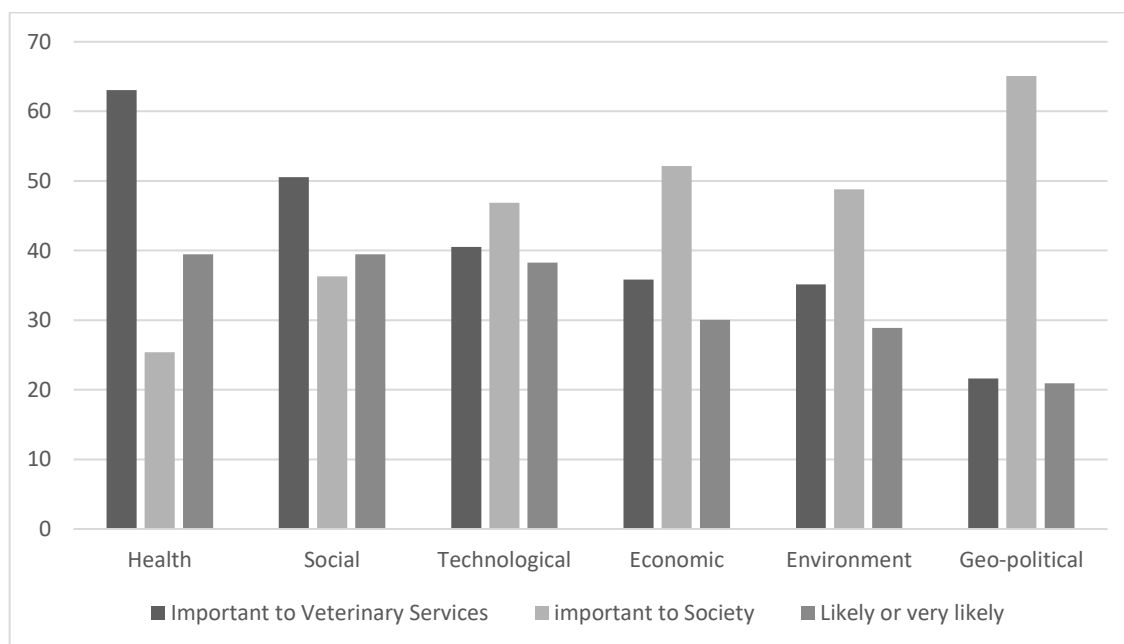

Fig. 1. Expert assessment of likelihood and importance of External Factors by category
(0 is the lowest and 100 the highest).

This long-list of 59 External Factors was shortened to a list of **17 External Factors** by selecting the factors that were both likely or very likely and of high importance to Veterinary Services according to the results of the Expert Survey.

4.2. Relevance of External Factors to the performance of Veterinary Services

The OIE Member Countries and Stakeholders were asked to assess several aspects of the 17 short-listed External Factors and select the five highest priority factors. They were also asked to judge the impact of External Factors on Veterinary Services (as opposed to society in general) in terms of how important it was and also whether the impacts were positive, negative or mixed. As shown in **Table I**, four out of the top five most relevant External Factors (**in bold in Table I**, see also Section 4.5) were related to health: half to animal health and half to human health.

Table I. OIE Member Countries (MC) and Stakeholder (SH) assessments of the key External Factors in terms of relevance and impact to Veterinary Services (VS): the score for relevance ranges from 0 to 2 (highest relevance); the impact on VS can be positive, negative or mixed.

Level of External Factor influence in 2030	MC Relevance to VS	SH Relevance to VS	Impact VS
Pandemics of disease affecting livestock (>1 of similar impact as peste des petites ruminants, at global level)	1.66	1.63	Slightly positive
Emerging diseases (> 5 new emerging infectious diseases [per country by 2030)	1.64	1.75	Somewhat positive
Emerging antimicrobial resistance	1.62	1.76	Mainly positive
Human zoonotic epidemic (>1 of similar global impact to that of SARS or more)	1.59	1.65	Mainly mixed
Increasing trade in livestock products (>30% of the livestock products globally traded in 2030)	1.56	1.57	Mainly positive
Animal welfare increasingly valued (>50% people in rich countries agree that animals should have similar rights to humans)	1.55	1.37	Somewhat positive
Intensive livestock production will increase by >10%	1.51	1.43	Mainly positive
Increasing role of international organisations (considerably more influential than now)	1.49	1.44	Very positive
Extreme weather events causing major catastrophes	1.44	1.45	Mainly negative
Per capita veterinary expenditure will increase (from USD 21 per person currently estimated to >USD 30)	1.43	1.08	Mainly positive
Biotechnology: widespread use in all aspects of agri-food system – new vaccines, diagnostics and therapeutics every year	1.42	1.66	Mainly positive
Major biodiversity loss (> one-third global current pristine ecosystems are substantially degraded)	1.39	1.45	Mainly negative
Blockchain used in more than 50% of animal and food traceability	1.37	1.22	Mainly positive
Rising foodborne diseases in low-and middle-income countries (>20 outbreaks similar to the 2011 *Escherichia coli* outbreak in Germany)	1.34	1.53	Mainly negative
Big data used in more than 10% of agri-food businesses and agencies	1.26	1.43	Mainly positive
Changing diets/western diets (high in processed food, sugar, salt and fat) dominate in >50% the world's countries	1.17	1.20	Mainly mixed
Relative contribution of livestock to greenhouse gas levels will decrease by >33% relative to current levels	1.16	1.16	Mainly positive

OIE Member Countries and Stakeholders had the possibility to indicate additional external factors that were not included in the list. While a few suggestions were made, Stakeholders came up with a much longer and broader list of additional External Factors, demonstrating the advantage of bringing in external perspectives, especially those with experience of Foresight. These included: mechanisation, synthetic biology, environmental impact of companion animals and genetic modification.

There was considerable similarity across regions in how relevant External Factors were considered to Veterinary Services by OIE Member Countries, but some differences. While human health related External Factors were seen as most important in all regions, trade increases were scored highest in Asia, the Far East and Oceania and reduction of greenhouse gases scored lowest in the Middle East.

4.3. OIE Member Country readiness in the face of External Factors

We considered readiness could be captured by (i) the concern regarding an External Factor; (ii) the amount of knowledge the Veterinary Services had about it; (iii) the current actions to adapt to the External Factor, and (iv) the current activities to prepare for future change.

i. Among the 17 short-listed External Factors, four were scored on average between 'very concerning' and 'extremely concerning' (*e.g.* livestock pandemics and worsening antimicrobial resistance, occurrence of more emerging infectious diseases and zoonoses), another eight between 'moderately concerning' and 'very concerning', and the remaining five between 'slightly' and 'moderately concerning' (*e.g.* change to western diets);

ii. Regarding knowledge and understanding of the External Factors, on average OIE Member Countries considered knowledge was between fair and strong for 12 External Factors, but between little and fair for five (biodiversity loss, big data, block chain, diet change and reduction in greenhouse gas);

iii. In terms of current actions to adapt to External Factors, on average OIE Member Countries reported they were conducting between few and some activities for 11 External Factors and between almost none and few activities for the remaining six;

iv. Regarding preparedness for future change in External Factors, on average OIE Member Countries reported they were between moderately and very prepared for 13 factors and between slightly and moderately prepared for four factors.

There was variation by region both the level of concern and the ability to do something about it. Overall, level of concern over External Factors tended to be higher in the Africa region and lower in the Middle East region.

An indicator of future readiness is the ability of the countries to make a judgement about the relevance, and importance of External Factors, and to be able to provide information on their activities concerning them. Overall, 72 countries were able to provide information on every External Factor. However, some countries did not have an opinion on some or many aspects of External Factors. We assessed four dimensions of readiness (concern, knowledge, activities for current events, activities for future events) across 17 External Factors. The maximum possible number of 'Don't know' responses was therefore 68. The reported mean number of "Don't Know" was, by region, Middle East (mean=8.7); Africa (6.2); Europe (4.8); Asia, the Far East and Oceania (4.1); Americas (2.6).

Involving external Stakeholders is an important part of Foresight. Where their perspectives agree with the that of the subject of the Foresight (here Veterinary Services), this can be a sign that the subjects' perspectives are valid. Where they disagree, this may mean that the Veterinary Services of Member Countries are not very accurate in their perceptions or that they are not adequately communicating their perceptions to Stakeholders. Overall there was an extremely strong correlation (r=0.92) between OIE Member Countries and Stakeholders. Stakeholders and OIE Member Countries were best aligned in perceptions regarding concern over External Factors. Moreover, Stakeholders tended to rate the knowledge, Adaptation and performance of Veterinary Services higher than OIE Member Countries rated it. The areas with most alignment (scores given by Member Countries and Stakeholders are most similar) and most difference (scores are least similar) are shown in **Table II**.

Table II. External Factors with most and least alignment regarding concern of Veterinary Services (VS) over External Factors between OIE Member Countries (MC) and Stakeholders (SH): the score ranges from 0 to 5.

	External Factor	MC	SH
Most alignment	VS *preparedness* for Biotechnology: widespread use in all aspects of agri-food system – new vaccines, diagnostics and therapeutics every year	2.78	2.78
	VS *current actions* on emerging antimicrobial resistance	3.68	3.69
	VS *concern* over rising foodborne diseases in low-and middle-income countries (>20 outbreaks similar to the 2011 *Escherichia coli* outbreak in Germany)	3.53	3.52
Least alignment	VS *knowledge* related to big data which could be used in more than 10% of agri-food businesses and agencies	2.31	2.95
	VS *knowledge* related to increasing role of international organisations (considerably more influential than now)	2.82	3.46
	VS *actions* oriented to a future increase in Intensive livestock production will increase by >10%	2.95	3.62

4.4 Risk matrices to help identify the priority External Factors

Classical risk matrices graphically present risks in terms of probability (likelihood) and impact.

Figure 2 shows the position of the 37 negative External Factors mapped by impact on the Veterinary Services and likelihood according to the results of the Expert Survey. High probability high importance events should be the core of routine planning: these include pandemics (number 36 in **Fig. 2**) and increasing foodborne disease (number 24).


Fig. 2. Risk matrix for the substantially **negative** External Factors by likelihood and impact on the Veterinary Services (0 is the lowest score and 100 the highest) according to the Expert Survey. External Factors are numbered from one to 37; the External Factors corresponding to each number are given in **Annex 2**.

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High impact, low probability events (bottom right hand quadrant) are especially difficult to plan for because they typically arise unexpectedly and behave in ways that are difficult to anticipate. They are sometimes referred to as 'mega-disasters' or 'black swan events'. These include failure of antimicrobials (number 2) and an animal mega-pandemic (number 1). Scenario analysis can be useful in planning for these. A common problem with risk management is maintaining registers of dozens or hundreds of risks. Management is most effective when a small number of External Factors are prioritised, and low impact, low probability External Factors should be noted but not highly prioritised (bottom left hand quadrant). These include energy price shock (number 8) and mass involuntary migration (number 20).

Annex 2 presents an additional risk matrix for the impact of External Factors on **Veterinary Services** that most experts believed **positive** (wealth increases) or substantially positive (i.e. **mixed** impact such as for increasing organic farming) and two risk matrices for the impact of the same External Factors (negative and positive/mixed) on **society in general** rather than Veterinary Services.

Another type of risk matrix (**Fig. 3**) was applied to the results of the questionnaire to OIE Member Countries to identify priority External Factors according to two different variables. These variables were the importance of individual External Factors to the Veterinary Services and preparedness of the Veterinary Service to deal with them. External Factors of high importance, but for which preparedness is low, may require more attention from Veterinary Services than External Factors of high importance and high preparedness (**Fig. 3**). It is interesting to note that OIE Member Countries are not highly prepared for the External Factors they consider of low importance for the Veterinary Services, indicating rational resource allocation.
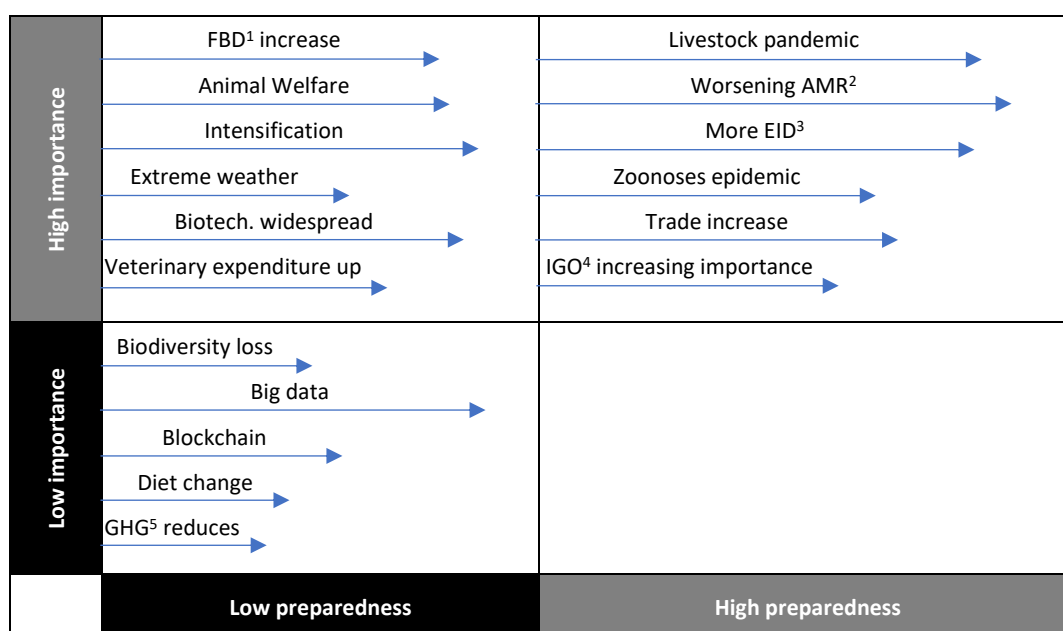
[1] FBD = Foodborne disease
[2] AMR = Antimicrobial resistance
[3] EID = Emerging infectious diseases
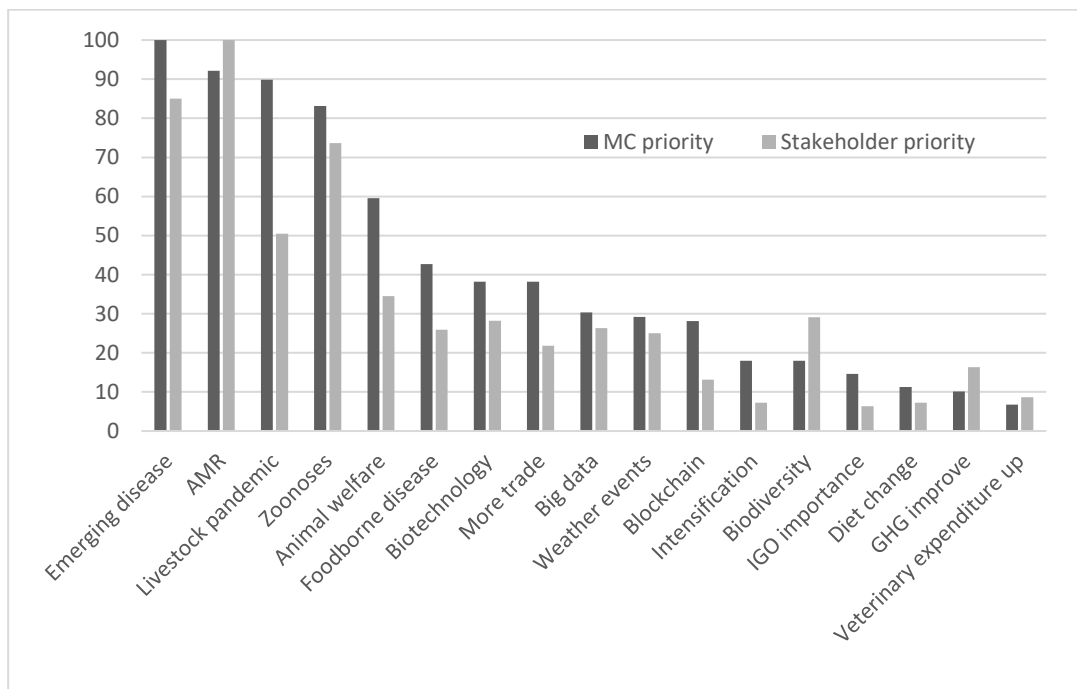[4] IGO = Inter-governmental organisations
[5] GHG = Greenhouse gases

Fig. 3. OIE Member Country assessment of the importance of and their preparedness for External Factors. The figure shows a limited number of key External Factors as an example.

4.5 OIE Member evaluation of the top five priority External Factors

OIE Member Countries and Stakeholders were also asked to identify their top five priorities. These are shown in **Fig. 4**. All of the top five priorities for OIE Member Countries except increasing concern over animal welfare are found in the High Importance-High Preparedness quadrant of the Risk Readiness Matrix. However, only one of the six External Factors in the High Importance-Low Preparedness quadrant is in the top five priorities (foodborne disease). This suggests that mainly non-health External Factors are being neglected by OIE Member Countries.

Stakeholders perceptions of what should be the External Factors of high priority is very similar to that of OIE Member Countries. The top three priorities for OIE Member Countries are emerging disease, antimicrobial resistance and animal pandemics, while the top three for Stakeholders are antimicrobial resistance, emerging disease and zoonoses. The main differences are that Stakeholders think biodiversity, antimicrobial resistance and reductions in greenhouse gas emissions should be higher priority and rate livestock pandemics, animal welfare and foodborne disease as a lower priority.

AMR: antimicrobial resistance increases; IGO: inter-governmental organisations; GHG: greenhouse gases.

Fig. 4. OIE Member Country (MC) and Stakeholder top five External Factor priorities (External Factors with the highest score is set at 100).

4.6. Additional focus on External Factors related to climate change

The 59 factors considered in the Expert Survey included nine environment related External Factors. In order to better understand preparedness in the face of climate change, we gave some additional questions. Encouragingly, clean energy was considered moderately likely and slightly less than moderately relevant to Veterinary Services by OIE member Countries. However, preparedness was not high. The likelihood of climate change mitigation and Adaptation failing, resulting in a warmer world but where the temperature increase would be less than 6 degrees, was also considered moderately likely and moderately relevant, but preparedness was even lower. The possibility of run-away global warming where temperatures increase by more than 6 degrees was seen as less likely, but even more relevant in its potential to result in huge impacts on the operation of Veterinary Services, and the level of preparedness was lowest. Again, the correlation between OIE Member Countries' perception and Stakeholders' perception was very high. Moreover, apart from 'clean energy', the Stakeholders rated the relevance to Veterinary Services higher than the OIE Member Countries did, but the preparedness of the Veterinary Services as lower.

5. The four future scenarios

Scenario planning is a tool used to assess and improve preparedness. Scenarios are not predictions, forecasts, or speculations, but a way to explore issues characterised by uncertainty and complexity. Based on the results of the Expert Survey, a workshop developed the following four scenarios to help understand how External Factors (*e.g.* climate change, conflicts, socio-economics, trading patterns) will impact Veterinary Services and the Adaptations required. These represent a small range of the possible futures. Respondents were presented with four scenarios: a baseline scenario, a preferred future scenario, and two wild card scenarios (each based on a surprising and unpredictable event, that would change the course of the future).

5.1. Baseline scenario: Business as Usual

The 'Business as Usual' scenario assumes that current trends and patterns will continue in the same direction from now to 2030 without major disruptions. Usually, 'Business as Usual' scenario projections do not accurately predict the future. However, these projections have been proved to be relevant for policy planning, and in particular for assessing preparedness in the face of highly probable and highly relevant trends and External Factors. Because the scenario is based on trends considered likely and relevant, they should be incorporated in Veterinary Services planning. The 'Business as Usual' scenario assumes that climate change will continue but the increase would be less than 6 degrees centigrade by 2030 and there would be no climate related events of sufficient magnitude to exceed the global ability to cope.

OIE Member Countries gave their judgement on the External Factors driving this scenario (**Table III**). Most of the External Factors, with the exception of moderate to high global warming, were seen as more likely than not, and all the External Factors were seen to have more than a moderate impact on Veterinary Services. OIE Member Countries see the Veterinary Services as best able to respond to change in External Factors that are closest to their core mandate, which are animal health and production. OIE Member Countries added up to three additional External Factors that would drive the 'Business as Usual' scenario: these were also dominated by animal disease-specific issues.

Table III. External Factors that are likely to continue and for which Veterinary Services should be prepared (0 is the lowest score for likelihood and preparedness and 5 the highest).

External Factors	Likelihood	Impact on the Veterinary Services	Veterinary Services can respond
Increasing urbanisation	3.83	3.42	2.77
Animal welfare concerns mount	3.73	3.58	3.07
Production intensifying	3.63	3.56	3.02
Big data increasing	3.53	3.33	2.79
Decentralising government	3.02	3.24	2.82
Temperature increases up to 6 C○	2.79	3.55	2.39

Foresight is not just about being well prepared for risks and problems, it also helps to identify and seize opportunities. OIE Member Countries were asked to provide three major opportunities for Veterinary Services in the Business as Usual scenario. They provided 204 opportunities covering a wide range from embracing new technologies, improving education and increasing investment in Veterinary Services.

Foresight aims to improve planning to strengthen preparedness. OIE Member countries identified a comprehensive list of actions for the next two to three years that would result in being better able to cope with the predicted world of 2030. Some of these entailed continuing what is being done, for example, continue to work in One Health. Many actions involved training and capacity building, but improving networking and collaboration was also commonly cited.

Finally, OIE Member Countries were asked to rate the skills and competencies most useful to Veterinary Services under this scenario. Overall, most highly rated were those related to data management (epidemiology and risk analysis). There were differences between regions, with, for example, clinical services rated most highly by OIE Member Countries from Middle East, epidemiology in Europe, economics in Africa and information management in the Americas.

5.2. Preferred future scenario: Green Growth with Equity

Scenario planning often involves a preferred or desired future. This is value-driven and used to help explore what actions could help bring this about. A detailed scenario was developed, which was based on eight positive External Factors (e.g. animal production is profitable and sustainable; animal production uses state-of-the-art technologies and infrastructure; partnerships between the private and public sectors are strong; and greenhouse gas emissions from animal production trend downwards). For these, OIE Member Countries estimated their likelihood, the current influence of the Veterinary Services and their potential influence.

OIE Member Countries saw all the External Factors more likely than not, except for decreasing greenhouse gas from animal production, which was seen as less likely. OIE Member countries also saw the Veterinary Services as having moderate or above influence on all the External Factors. Furthermore, for every External Factor, they rated the potential influence of Veterinary Services as even higher. The difference between current influence and potential influence was highest for uptake of new technology in animal production and garnering more public support for animal production.

There were some differences but more similarities in current and potential influence of the Veterinary Service on these eight positive External Factors across the OIE regions. When the likelihood, current influence and potential influence are scored across the External Factors, we see, for example Members in the Americas region have the lowest current influence but are most optimistic for future potential influence (**Fig. 5**).
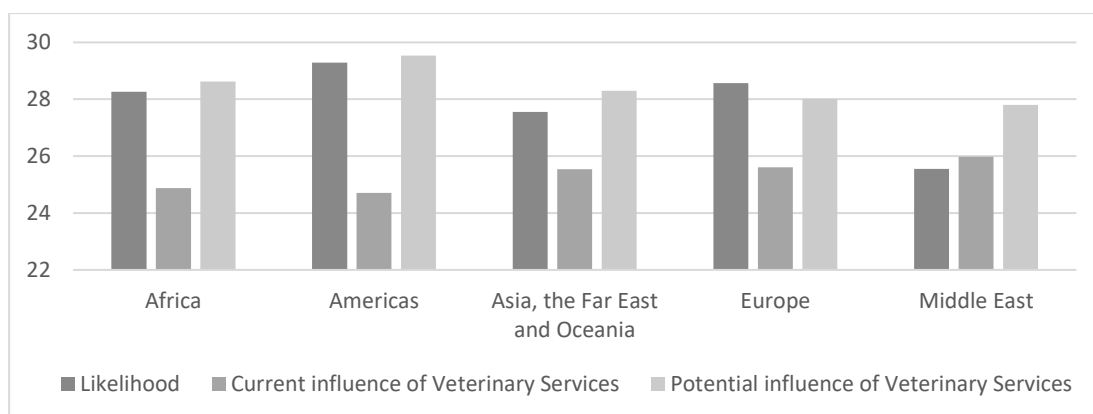

Fig. 5. External Factors that could drive a preferred future by OIE region (the combined score of all 8 External Factors, where the score of each External Factor can range from 0 to 5).

OIE Member Countries made 208 broad ranging suggestions for actions that Veterinary Services could do in the next two to three years that would increase the likelihood of attaining the desired future of Green Growth with Equity. These suggestions can form the basis for action plans and for tracking progress.

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5.3. Alternative (wild card) scenarios: No-Meat World and the Coming Plague

Alternative future scenarios are generated with at least one plausible uncertainty at their core. This can be something positive or negative. Alternative scenarios are not meant to be confident predictions. Their value is in helping better adapt to unknowns. Typically, one to three vividly contrasting alternative futures are developed. For this questionnaire, we considered two alternative scenarios: 'The No-Meat World' and 'The Coming Plague'.

In 'The No-Meat World' a combination of technological change (cheap artificial meat), social contagion (vegetarianism becomes popular) and disease concerns has led to a dramatic shift away from animal source foods in diets. Most OIE Member Countries thought that most of their activities would be irrelevant in this world, i.e. 97% of respondents from the African region, 92% from Asia, the Far East and Oceania, 90% from the Middle East, 87% of those from the Americas and 69% from Europe.

We also used this scenario to help OIE Member Countries explore resilience. Only a small number of countries had experienced changes in the livestock sector as comprehensive as would occur in 'The No-Meat World' scenario (10 Member Countries, i.e. 6% of respondents). These OIE Member countries were then asked what factors helped cope with these major changes and gave a broad range of useful advice. While some of this was specific to the crisis faced, other advice is generalisable such as 'Adaptability and flexibility to cope with changing world situations' and 'One Health'.

'The Coming Plague' scenario was set in a future where a major zoonotic pandemic was occurring, an external event that was considered possible and important for Veterinary Services and the society. This section was designed to understand OIE Member Countries awareness of how they would deal with a crisis. As such, much of the information was country-specific and difficult to aggregate. The first question asked which designated authority would be responsible. Overall, 84% of respondents were able to name an authority. Many others named several authorities without saying who would lead; this can be a risk in an emergency. However, many OIE Member Countries also mentioned a co-ordinating mechanism. In at least 43% of respondents, a veterinary, livestock or agriculture authority was named. There was a very broad range in the type of authority, from Veterinary Services, to Ministries of Health, to crisis management centres, to the military. Member Countries were also asked to identify threats and opportunities, and most were able to provide credible and useful information, indicating a good level of preparedness.

Well-crafted scenarios help in improving the quantity and quality of analysis. When Member Countries were asked to respond in the context of a scenario, the answers provided were more detailed and appeared more accurate.

6. Current future-facing activities

6.1. Current activities to assess External Factors (Environmental Scanning)

Most responding OIE Members (63%) reported conducting activities to understand how External Factors such as climate change, conflicts, socio-economics and trading patterns might affect their national Veterinary Services (in planning terminology, this is referred to as Environmental Scanning). Most activities require some level of planning, and reasonable plans should consider External Factors. It is possible that some OIE Member Countries are assessing External Factors but interpreted the question narrowly, to mean formal studies focused on one or more of the examples given. This suggests a lack of familiarity with planning and management terminology.

6.2. Member Countries assessment of their capacity to conduct activities to understand External Factors

Overall, just over half (55%) of responding OIE Member Countries considered that their capacity to engage in activities to understand the challenges and opportunities of External Factors other than climate change was adequate or above, while just under half of respondents (48%) felt that their capacity specific to climate change was adequate or above. There were regional differences with tendencies to perceive greater deficiencies in countries from the Africa and Americas region. The correlation between the two capacity assessments (*i.e.* capacity towards external factors other than climate change and capacity towards climate change) was very strong (r=0.77).

Stakeholders were also asked to assess the Veterinary Service Capacity towards external factors other than climate change and capacity towards climate change. The questions were slightly different. Veterinary Service capacity would be expected to vary with the level of economic development. Stakeholders were pessimistic of capacity to manage External Factors in general and for climate change. Unsurprisingly, they tended to rate the capacity of Veterinary Services in high-income countries higher than in less economically developed countries.

6.3. Current assessments of External Factors relevant to future performance

OIE Member Countries that reported that they assess External Factors (86, i.e. 63% of respondents) were asked about a range of activities that are relevant to future performance.

- Strategy development and planning. While 97% of OIE Member Countries who assessed External Factors conducted strategy development and planning, a slightly smaller proportion (88%) reported having staff dedicated to this. A similar proportion of Stakeholder respondents considered that Veterinary Services conduct strategy and planning (84%). Thirty-nine responding OIE Member Countries were able to provide at least one example of strategy and planning documentation and 21 also provided a web-link. Strategy and planning documents covered a wide range from controlling specific diseases, to sectoral development, to institutional strategy. Only two specifically addressed climate change (3% of all strategy documents provided).

- Animal health related risk assessment. Most OIE Member Countries who reported that they assess External Factors had staff in the Veterinary Services working on animal related disease risk analysis (88%). Only 4% of respondents specified they did not have staff working on risk analysis and the remainder did not respond. Most Stakeholder respondents (85%) also considered that animal disease related risk assessment was carried out by Veterinary Services. Disease risk analyses were most commonly reported (86% of OIE Member Countries). Although 78 OIE Member Countries had carried out animal-related diseases risk analyses in the last two years, just 38 were able to provide information on the availability of documentation. Half provided web links and the other half said reports were only available in hard copy or were confidential. Of those that could provide web links, three quarters were high-income countries and the remaining middle-income countries.

- Institutional risk assessment. Of the 86 OIE Member Countries who reported assessing External Factors, 51 (59%) reported conducting analyses of institutional risk. OIE Member Countries from the Europe region were most likely to conduct institutional risk assessments. Just under 50% of Stakeholder respondents thought that Veterinary Services carried out institutional risk assessment. There was some discrepancy in reporting between responses to the question of conducting institutional risk assessment and questions concerning specific risk assessments. This again suggests unfamiliarity with management terminology. Financial risk assessment was most common, followed by Human Resources, Effectiveness, Reputation, Regulatory, Legal, Mandate and Operational. OIE Member Countries were likely to assess risk across several categories or none at all. However, only 25 evaluated risk in all eight categories (10 of these were from the Europe region). Those OIE Member Countries who reported that they assess institutional risk, considered it important. On a scale where 1 is not important and 5 is extremely important, the average score was close to 5.

- Foresight. Foresight exercises were defined as a set of planning activities that are systematic, participatory and multi-disciplinary and involve consideration of External Factors. Only 40% of OIE Member Countries who reported that they assess External Factors had staff working on Foresight, and only 44% of them reported conducting Foresight, while 43% of Stakeholder respondents believed Veterinary Services undertook Foresight exercises. Among those OIE Member Countries who undertook Foresight, only 3 had conducted more than ten Foresight exercises in the last two years. All OIE Member Countries reported that they engaged at least one external Stakeholder in the Foresight.

On average 6.4 other Stakeholders were included. The most frequently included were other government institutions and Farmers Associations. The general public and research institutes outside academia were least likely to be included.

6.4. Priority diseases

Nearly all (96%) of responding OIE Member Countries (n=131) had a list of priority animal diseases. Just five countries said there was no priority list of diseases, and another six did not answer the question. Countries with no priority list mainly had very limited primary production of livestock and fish. Almost all of responding OIE Member Countries were also able to name the unity or entity responsible for setting priorities.

All OIE Member Countries used several of the eight criteria we suggested to prioritise diseases. The most important criterion was the presence of the disease on the OIE List. The economic, trade and zoonotic burdens were also used by nearly all respondents. Feasibility and cost benefit of control criteria were used by fewer, and social and environmental burden by the least. Thirty-three OIE Member Countries used additional criteria but, accounting for duplication, only 22 additional criteria were given: the most common was presence of disease in a neighbouring country. This suggests the eight criteria capture most of the factors taken into account when diseases are prioritised. Interestingly, impact or burden were used by more countries than feasibility or cost-benefit of control and environmental impact was considered the least important.

Most Stakeholders considered that Veterinary Services used the OIE List, economic impact, trade, feasibility of control and environmental impact to prioritise disease. Mostly these corresponded closely with the OIE Member Countries' responses. However, 88% of Stakeholders and 70% of OIE Member Countries thought Veterinary Services used environmental impact as a criterion.

In terms of importance, the presence of a disease on the OIE List was overall between very important and extremely important as were zoonotic and economic impact. Trade impact and feasibility of control were between moderately important and very important, and the other factors were between slightly important and moderately important. There were differences between regions: OIE Member Countries in the African region ranked Economic impact highest, and countries in the Americas region more likely to rank criteria other than the top four as less important. Stakeholders scoring of importance was quite similar. The greatest difference between perceptions of importance was for environmental impact, which Stakeholders scored considerably higher, followed by feasibility.

Only 22% of OIE Member Countries revised priority lists yearly and 38% had not revised lists in the last three years. OIE Member Countries in the Americas were most likely to revise yearly (35%) and Member Countries in the Africa region most likely to have not revised in the last three years (48%).

Overall, 61% of responding OIE Member Countries had formally identified different categories of priority disease among those proposed in the questionnaire (which may partly overlap). Unsurprisingly, countries were more likely to have official priority lists for zoonoses or animal diseases. However, 42% had official emerging disease lists, 29% foodborne disease lists and 17% climate sensitive disease lists. Only a few OIE Member Countries used categories other than those suggested. Additional categories used in some countries were: aquatic diseases; trade sensitive diseases; diseases of high mortality and morbidity; highly contagious diseases; diseases with nervous symptoms; and vesicular diseases.

7. Suggestions for increasing resilience, leveraging opportunities, and influencing for a preferred future in the context of External Factors

7.1. Main constraints to use of planning and Adaptation in the context of External Factors

OIE Member Countries were asked to rate the main constraints to effective use of both Foresight and Adaptation to External Factors by the Veterinary Services and 127 out of 131 were able to respond. All the constraints to Foresight were seen as, on average, between moderately and very important by the Veterinary Services, apart from lack of appropriate methods and lack of expertise which were seen as between very important and extremely important (**Table IV**). The most important constraint to Foresight was lack of expertise and the least important constraint was difficulty of co-ordination. There were differences between OIE regions, with the Americas perceiving the highest level of constraints overall and the Middle East the lowest.

Table IV. Constraints to effective use of Foresight by the Veterinary Services as perceived by OIE Member Countries. The mean score can range from 1 (least important) to 5 (most important).

Constraints	Africa	Americas	AFEO[1]	Europe	Middle East	World
Lack of standardised approaches and methods	4.20	4.22	3.84	4.18	3.78	4.09
Lack of expertise	4.23	4.30	4.04	3.91	3.44	4.06
Insufficient financial resources	4.16	4.26	3.96	3.68	4.00	3.99
Insufficient human resources	4.00	4.26	3.76	3.94	3.78	3.97
Lack of evidence on benefits	3.97	4.00	3.88	3.72	3.56	3.86
Lack of mandate to carry out this activity	3.97	3.83	4.04	3.56	3.44	3.80
Difficulty of co-ordinating with other Stakeholders	3.94	4.00	3.44	3.44	3.11	3.65

[1] AFEO = Asia, the Far East and Oceania

All the constraints to Adaptation by the Veterinary Services were seen as between moderately and very important by OIE Member Countries. Overall, constraints to Adaptation were seen as less important than constraints to use of Foresight. The most important constraint was lack of financial resources and the least important constraint was the lack of methods. There were differences between OIE regions, with the Americas perceiving most constraints overall and Europe the least.

Stakeholders tended to see the constraints to Foresight as less important, but the constraints to Adaptation as more important. Interestingly, OIE Member Countries' view on constraints to Adaptation was markedly similar to Stakeholders perception of the constraints to Foresight faced by the Veterinary Services. Only a small number of additional constraints were suggested by OIE Member Countries and Stakeholders, mainly related to government buy-in.

7.2. Actions that could overcome the barriers to use of planning for and Adaptation of Veterinary Services to External Factors

OIE Member Countries and Stakeholders were also asked to evaluate a series of potential activities to judge which could help improving the capacity of Veterinary services for planning (Foresight) and Adaptation to External Factors. Activities were scored by usefulness (not at all, moderately, extremely) and ease of carrying out (very easy, easy, difficult). Not counting those who did not offer an opinion, 124 Member Countries responded.

According to OIE Member Countries, the most useful activities for Veterinary Services were considered to be training in Foresight, organising in-country multisectoral working groups and practical workshops. Stakeholders also mostly supported the activities. Workshops and working groups were considered to be most useful. However, in terms of feasibility the very easy actions were considered to be including Foresight and Adaptation in annual planning, multi-sectoral in-country working groups and incorporation within the OIE Tool for the Evaluation of Performance of Veterinary Services (OIE PVS Tool). Stakeholders considered the easiest to be sharing information with other countries, organising workshops and incorporating in the OIE PVS pathway.

7.3. Identification of OIE PVS critical competencies most closely linked to Foresight and Adaptation

OIE Members countries also reviewed several critical competencies of the OIE PVS Tool (**Table V**), to assess which were most linked to Foresight and Adaptation and provide a rating from 0 (no links) to 5 (most links). Excluding OIE Member Countries who did not answer the question or replied with 'Don't know', this assessment was done by 125 Member Countries and 76 External Stakeholders. On average, only 1% of responding OIE Member Countries considered that there were very weak links, and no OIE Member Country reported that links were absent. The Critical Competencies with most relevance were those related to emergencies, technical skills and communication. Stakeholders were in broad agreement, although they generally identified links as weaker than OIE Member Countries did.

Table V. Links between OIE PVS Critical Competencies and Foresight and Adaptation (mean importance score with 1 least important and 5 most) according to OIE Member Countries.

Critical competencies	Africa	Americas	AFEO[1]	Europe	Middle East	World	Stakeholders
Emergency Preparedness and Response	4.27	4.52	4.44	4.56	4.20	4.43	4.21
Emergency funding	4.23	4.43	3.92	4.50	4.40	4.30	3.93
Professional and technical staffing of VS[2]	4.16	4.57	4.12	4.18	4.10	4.23	3.79
Risk Analysis	4.17	4.39	4.12	4.21	4.30	4.22	4.24
Communication	4.03	4.39	4.00	4.12	3.90	4.11	4.00
Planning, sustainability and management of policies and programmes	4.17	4.09	4.08	4.03	4.20	4.10	3.83
Coordination capability of the VS[2]	4.10	4.30	4.04	4.06	3.90	4.10	4.05
Operational funding	4.03	4.09	4.04	4.03	4.50	4.08	3.87
Physical resources and capital investment	3.97	4.09	4.28	3.85	3.80	4.01	3.66
Continuing education	4.00	4.35	3.92	3.76	4.10	3.99	3.89
Competencies of veterinarians and veterinary paraprofessionals	3.87	4.13	4.00	3.82	4.00	3.94	3.84
Transparency	3.83	4.35	3.88	3.52	4.00	3.87	3.74
Consultation	3.67	3.41	3.48	3.61	3.80	3.58	3.53
Technical independence	3.47	3.78	3.50	3.29	4.10	3.54	3.28
Animal Welfare	3.31	3.35	3.40	3.26	3.00	3.30	3.11

[1] AFEO = Asia, the Far East and Oceania
[2] VS = Veterinary Services

7.4. Role of the OIE in strengthening Veterinary Services capacity for Foresight and Adaptation in the face of External Factors

An important objective of the questionnaire was to explore how the OIE can best support its Members in the face of External Factors, especially climate change. Accordingly, we proposed a range of possible OIE-led activities and asked respondents to rate them according to utility (less useful, useful, very useful) and applicability (difficult, very easy, easy). These ratings were turned into scores with 'very useful' and 'useful' given a weight of two, 'useful' and 'easy' a weight of one, and 'difficult' and 'less useful' a weight of minus one. They were then added to obtain an overall score for both utility and applicability which was standardised. The options were as follows, and the mapping is shown in **Figure 6**.

- Receiving training in foresight methods and approaches such as scenario analysis or horizon scanning;

- Organise working groups on external factors with representatives of each of the Stakeholders and with the Veterinary Authority of your country (summarised as VS Working Group in **Figure 6**);

- Organise practical workshops targeting 'at risk' geographical areas or sectors (workshops);

- Sharing information on foresight and Adaptation materials produced by the Veterinary Services of other countries (international sharing);

- Including Foresight and Adaptation activities in annual planning processes of the Veterinary Services of your country (foresight in annual planning);

- Organise a working group or coordination group on Foresight and Adaptation with Stakeholders from outside the Veterinary Services of your country (broad working group);

- Propose to include principles and methods to conduct Foresight and Adaptation exercises explicitly in the OIE PVS pathway (foresight in PVS pathway).
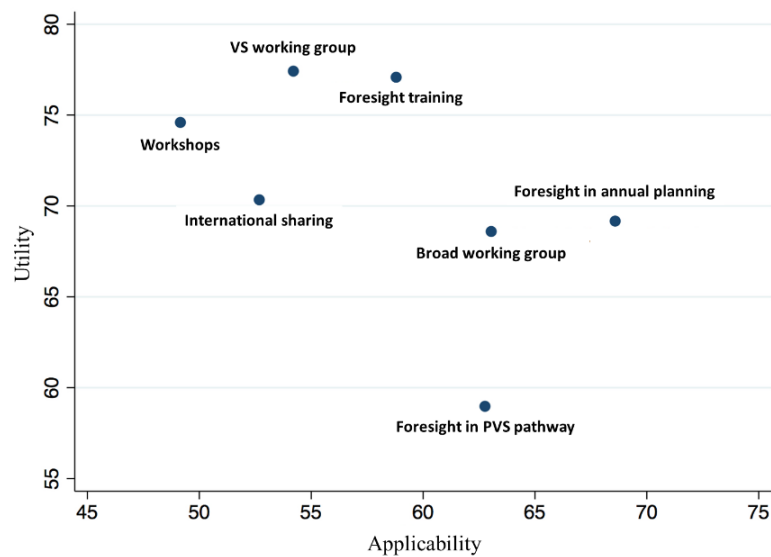

Fig. 6. Potential OIE support activities mapped by utility score and ease of applicability score
(0 is least and 100 is highest possible).

How external factors will impact Veterinary Services and the adaptations required

7.5. Operationalising capacity building for Foresight and Adaptation

OIE Member Countries were also asked to rate the suitability of different actors for providing training. Most of the options were considered to be suitable providers of capacity building with inter-governmental organisations (IGO) scoring highest and non-governmental organisations scoring lowest (**Fig. 7**).
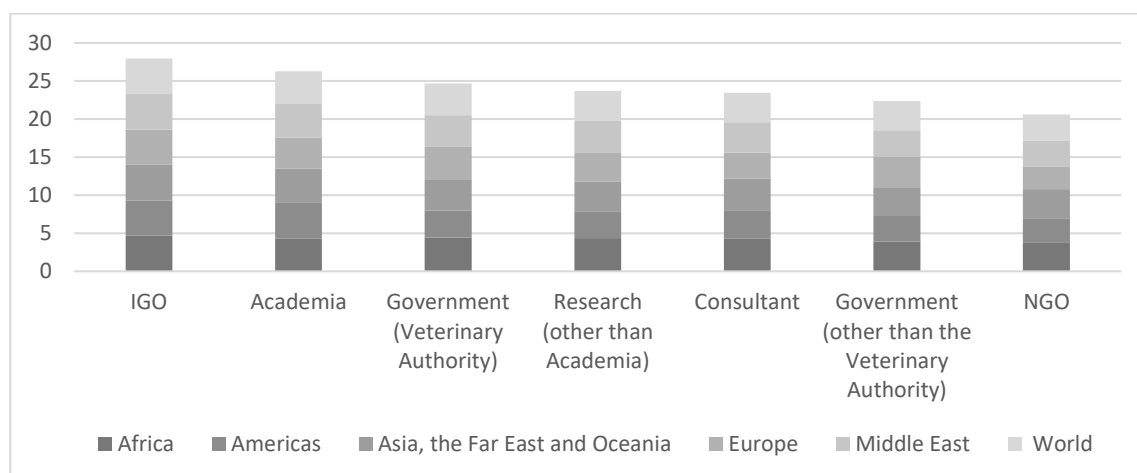

Fig. 7. OIE Member Countries scoring of potential providers of training in Foresight and Adaptation (importance score with 0 least and 25 most important)

OIE Member Countries were also asked which other Stakeholders should be involved in conducting Foresight activities in collaboration with the Veterinary Services (**Table VI**). Notably, more than half the respondents believed other actors should be involved across nearly all categories of Stakeholder group (with the exceptions being private consultants, the general public and non-governmental organisations). There were differences by region, with for example the Americas being least likely to report the general public should be involved and the Africa region being most likely to report that consumers organisations should be involved. This is in line with the principle that Foresight activities should be participatory and involve a range of Stakeholders.

Table VI. OIE Member Countries opinion (in %) on who should be involved in collaborating with the Veterinary Services on Foresight activities.

Collaborators	Definitely not	Probably not	Don't know	Probably yes	Definitely yes
Other governmental institutions within the VS[1]	4	6	16	21	51
Other governmental institutions outside the VS[1]	2	5	19	35	36
Private consultants or consulting firms -	5	8	42	34	9
Private veterinarians	1	5	27	35	31
Livestock industry	2	6	17	34	40
Farmer associations	1	4	20	31	41
Consumer organisations	3	6	35	35	18
General public	6	22	33	27	10
Academia	1	6	26	34	31
Research organisations outside the academia	2	11	27	35	23
Non-governmental organisations (NGOs)	3	15	31	37	12

[1] VS = Veterinary Services

8. Discussion and conclusions

The main objective of the questionnaire was to better understand how External Factors, especially climate change, might affect the work of the Veterinary Services, how prepared Veterinary Services were for these and what could help them be better ready. We used a systematic process to generate a long and then short list of key External Factors and added three others to ensure climate change was covered.

A first finding is that there are many External Factors that could impact on Veterinary Services in the next ten years. Most of the OIE Member Countries are concerned about the impact of External Factors on the Veterinary Services. We used scores to quantify different dimensions External Factors. The mean score for 'concern' was higher than the score for 'knowledge' which was higher than the score for 'level of the activities of Veterinary Services to adapt to current change', which was in turn higher than score for 'level of activities directed to future change'. OIE Member Countries understandably highly prioritise health related External Factors, but consider also social, technological, geo-political and environmental factors.

We used risk matrices to help in reducing the risk register to a more manageable list of External Factors which cannot be ignored. High impact – high likelihood threats are headed by livestock pandemics, worsening antimicrobial resistance and more emerging diseases. In terms of preparedness, high impact-low likelihood threats seem to receive less attention. By comparing the importance of External Factors, we identified threats that should probably receive more attention, including increase in foodborne disease, rising concerns about animal welfare, and animal intensification.

Three of the four highest priority External Factors as rated by OIE Member Countries have human health links (emerging disease, antimicrobial resistance and zoonoses). This reflects the important contribution of Veterinary Services to the Sustainable Development Goals, including through their role in Veterinary Public Health. While External Stakeholders are in broad agreement with Veterinary Services prioritisation of External Factors, they tend to emphasise human health and the environment more.

Scenario planning is a tool used to assess and improve preparedness. Scenarios are not predictions, forecasts, or speculation, but a way to explore issues characterised by uncertainty and complexity. External Factors can be negative or positive, but the focus of OIE Member Countries was directed towards managing emergencies rather than fostering positive trends. The Green Growth with Equity scenario represented a preferred future. OIE Member Countries considered they had moderate or higher influence on most of the External Factors and that the potential influence of Veterinary Services was higher still. The Business as Usual scenario assumed that climate change will continue but that the increase would remain below 6 degrees Celsius by 2030 and there will be no climate related events which exceed the global ability to cope. Under this scenario, OIE Member Countries considered that Veterinary Services were less than moderately able to respond to most External Factors, but still able to identify opportunities and action which, if undertaken in the next three years, would leave them better prepared. The other two wildcard scenarios examined extreme cases. In general, OIE Member Countries were not well prepared for a world where animal farming was radically different but were moderately prepared for a zoonotic pandemic.

Planning becomes more important in times of uncertainty. Although most OIE Member Countries are concerned about a number of External Factors, less than two thirds consider that they assess them. Moreover, both OIE Member Countries and Stakeholders perceive that Veterinary Service capacity in the face of External Factors is often weak. The most common activity involving assessment of External Factors is planning and animal disease related risk assessment but less than half conduct Foresight and just over half assess the institutional risks that could undermine performance. There was a lack of publicly available documentation on the outputs of these analyses and a strong 'digital divide' whereby low-income countries reported much fewer documents on websites. Many OIE Member Countries did not appear familiar with planning and management language or thinking. Among the strategy and development documents reported, climate change is neglected. However, OIE Member Countries consider planning, disease risk assessment, institutional risk assessment and Foresight to be important tools for preparing the Veterinary Services for an uncertain future. Using scenarios improved both the quality and quantity of Veterinary Services assessments.

Disease prioritisation is an important process for targeting scarce resources. Nearly all OIE Member Countries have a priority animal disease list and nearly all use multiple criteria. In addition, more than half of OIE Member Countries prioritised disease along different categories, such as priority climate sensitive diseases and priority zoonoses. Disease impact or burden is used by more countries than feasibility or cost-benefit of control, and environmental impact was considered the least important criterion. However, Stakeholders consider these last two criteria to be more important, suggesting that prioritisation processes can be improved.

The third objective of the questionnaire was to identify how the OIE could assist its Members in improving the Veterinary Services' capacity building for Foresight and Adaptation to External Factors. OIE Member countries identified the most important constraints to Foresight for Veterinary Services as lack of appropriate methods and lack of expertise, while the main constraint to Adaptation was lack of financial resources. In terms of areas of potential OIE support, working groups within the Veterinary Services were seen as especially useful and incorporating Foresight in the OIE PVS pathway as especially easy. OIE Member Countries also identified how Foresight linked to OIE PVS Critical Competencies: the highest link was found for emergency and technical related competencies.

Across all of the topics covered in the questionnaire there are differences between OIE regions, but the commonalities are much stronger. There was also a high agreement between the perspectives of OIE Member Countries and Stakeholders on the characteristics and performance of Veterinary Services. This suggests that OIE Member Countries have an accurate understanding of the reality around the Veterinary Services and the capacity of the Veterinary Services to communicate well to External Stakeholders. At the same time, Stakeholders consistently rated the environment and climate change more highly and also suggested a broader range of possibilities and options than OIE Member Countries did, showing the value of including external perspectives in planning.

In conclusion, OIE Member Countries are concerned over key External Factors, including climate change. They also consider that the Veterinary Services have considerable competencies in knowledge, action and preparedness but these are more oriented to health and to managing emergencies than to broader issues or influencing for a preferred future. Future-facing activities are seen as very important, but many OIE Member Countries feel that the Veterinary services still lack skills in this area and would appreciate initiatives to improve their preparedness in the face of External Factors.

9. Key recommendations

Member Countries and the OIE should:

- Consider how External Factors might affect the performance of Veterinary Services over the next ten years;

- Develop a risk register to monitor the most important threats;

- Conduct institutional risk assessment for key areas such as finance, legal and operations;

- Consider using Foresight tools such as risk matrices and scenario planning to help in planning;

- Pay more attention to high impact low probability events;

- Pay more attention to areas more highly prioritised by Stakeholders and of greater impact on society such as climate change;

- Develop strategies to increase their influence to bring about the future they desire;

- Explore opportunities for strengthening capacity, especially in constituting working groups within the Veterinary Services and seeking training opportunities in Foresight and improving general management, planning and leadership skills;

- Participate in initiatives to prioritise diseases in ways that meet the needs of Stakeholders;

- Continue their success in being regarded as relevant and able to respond to External Factors.

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…/Annexes

Responding countries classified by OIE region for the purposes of the study

Africa

Benin; Botswana, Burkina Faso; Cabo Verde; Cameroon; Comoros; Congo (Dem. Rep. of the); Congo (Rep. of the); Cote d'Ivoire; Djibouti; Egypt; Eritrea; Ethiopia; Gabon; Gambia Ghana; Guinea; Guinea-Bissau; Malawi; Mali; Mauritania; Mauritius; Morocco; Mozambique; Nigeria; Rwanda; Senegal; Seychelles; Sierra Leone; Somalia; South Africa.

Americas

Argentina; Barbados; Belize; Bolivia; Brazil; Canada; Chile; Colombia; Costa Rica; Cuba; Curaçao; Ecuador; El Salvador; Guatemala; Guyana; Haiti; Honduras; Mexico Nicaragua; Panama; Paraguay; Peru; Saint Lucia; Suriname; United States of America; Uruguay; Venezuela.

Asia, the Far East and Oceania

Australia; Bangladesh; Bhutan; China (People's Rep. of); Fiji; India; Indonesia; Japan; Korea (Rep. of); Laos; Malaysia; Maldives; Micronesia (Federated States of); Myanmar; Nepal; New Caledonia; New Zealand; Papua New Guinea; Philippines; Singapore; Sri Lanka; Taipei china; Thailand; Timor-Leste; Vanuatu.

Europe

Armenia; Austria; Azerbaijan; Belgium; Bosnia and Herzegovina; Cyprus; Czech Republic; Denmark; Finland; North Macedonia; France; Georgia; Germany; Greece; Hungary; Ireland; Israel; Italy; Kyrgyzstan; Liechtenstein; Lithuania; Malta; Moldova; Montenegro; Netherlands; Norway; Poland; Portugal; Romania; Russia; San Marino; Serbia; Slovakia; Slovenia; Spain; Sweden; Switzerland; United Kingdom.

Middle East

Afghanistan; Bahrain; Iran; Iraq; Jordan; Kuwait; Oman; Saudi Arabia; Syria; Turkey.

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Additional risk matrices and lists of External Factors by positive/mixed or negative impact

Risk matrix for **positive or mixed** External Factors by likelihood (Likely) and impact on **Veterinary Services** (Imp_Vet)
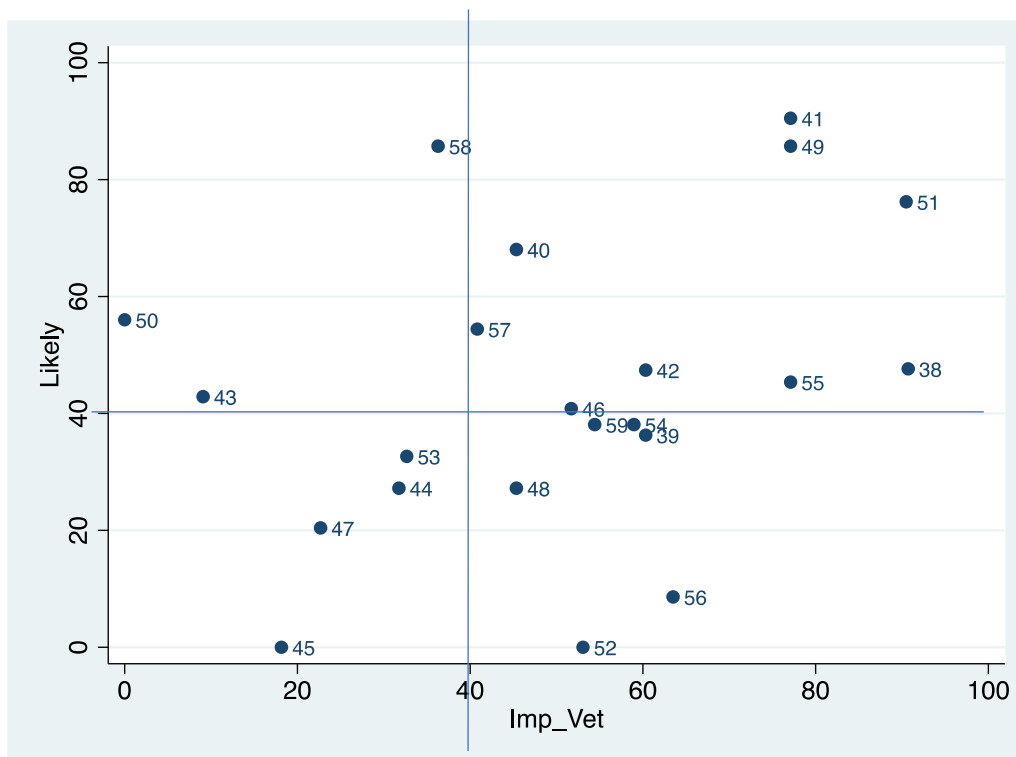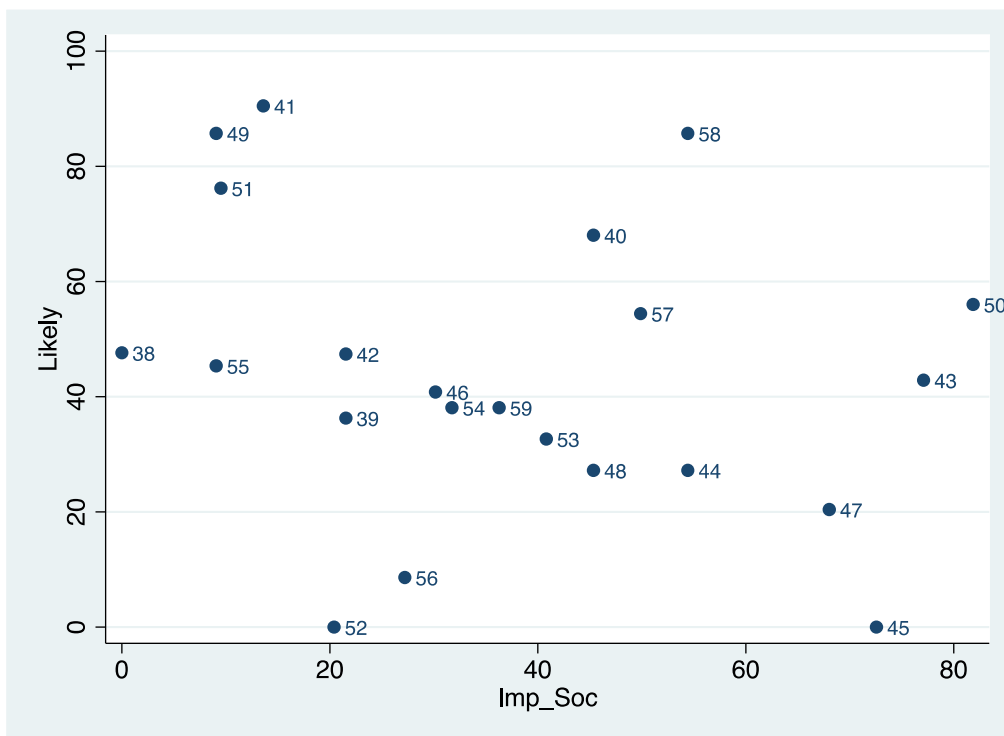

(The External Factors corresponding to each number are given in the lists below)

Risk matrix for **negative** External Factors by likelihood (Likely) and impact on **society in general** (Imp_Soc)
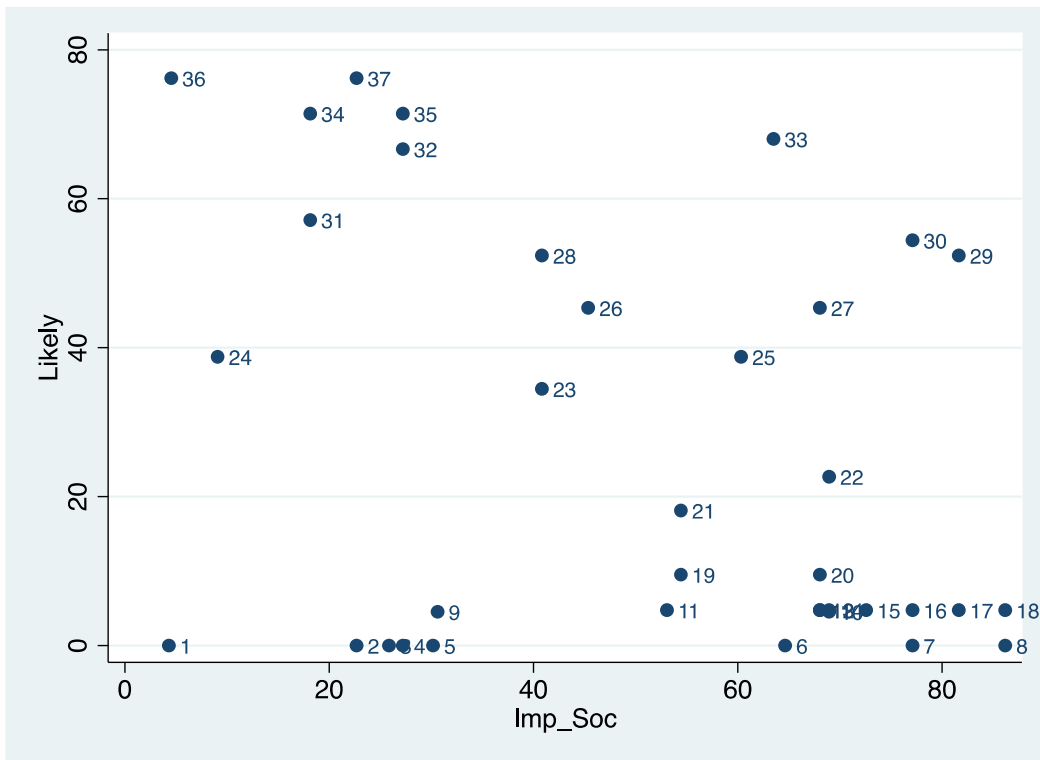
Risk matrix for **positive or mixed** External Factors by likelihood (Likely) and impact on **society in general** (Imp_Soc)

(The External Factors corresponding to each number are given in the lists below)

How external factors will impact Veterinary Services and the adaptations required

List of External Factors that are generally regarded as having predominantly **negative** impacts. Numbers are only for ease of reference and do not indicate an increasing level of negative impact.

No.	Expert Elicitation External Factors
1	Animal mega pandemic (rinderpest or worse)
2	Antimicrobials stop working and don't have substitutes
3	Zoonotic mega pandemic (similar to Black Death or worse)
4	Major foodborne disease outbreak (with multi resistant pathogen)
5	Bioterrorism using animal/zoonotic pathogens
6	Runaway global warming (> 6 degrees)
7	Major adverse unintended consequences of technology
8	Energy price shock (1970s or worse)
9	Ecosystem collapse and death of thousands of people such as occurred at the end of the bronze age
10	Continued decline in countries considered 'Free' (from current 45% of world's countries to <33% countries)
11	Water crisis - no water for one third or more people
12	Fiscal crisis in key economy (1930s depression or worse)
13	Return to protectionism – trade declines by one third or more
14	Cybercrime causes major institutions to stop functioning
15	Failure of governance or civil war similar to Somalia crisis or worse
16	Critical information infrastructure breakdown
17	Interstate conflict similar to Cold War or worse
18	Large scale terrorist attacks (World Trade Centre or worse)
19	Food price shock (2008 crisis or worse)
20	Mass involuntary migration – hundreds of millions of people
21	Extreme weather events causing major catastrophes
22	Increasing fragmentation (> 10 countries become less regionally integrated)
23	Illicit trade increases (equalling or exceeding legal trade by 2030)
24	The proportion of veterinarians with livestock expertise continues to decline (by 10% or more)
25	Population growth above predicted levels (> predicted 8.5 billion by 2030)
26	Changing diets (western diets – high in processed food, sugar, salt and fat- will dominate in >50% the world's countries)
27	Trust in government continues to decline (from 42% of people in rich countries trust government to less than 20%)
28	Major biodiversity loss (> one third global current pristine ecosystems are substantially degraded)
29	Failure of climate change mitigation & Adaptation (in >50% countries globally)
30	Rising human chronic disease (from 70% of global deaths now to >90% of global deaths)
31	Human zoonotic epidemic (>1 of similar impact to that of SARS or more)
32	Emerging antimicrobial resistance (with agriculture considered responsible for 30% or more)
33	Deep poverty concentrated in Africa (> 75% of the extreme poor in Africa)

No.	
34	Increasing vector borne disease prevalence (substantial increase from current levels)
35	Rising foodborne disease in LMIC (>20 outbreaks similar to the 2019 listeriosis in South Africa or 2011 *Escherichia coli* outbreak in Germany)
36	Pandemics of disease affecting livestock (>1 of similar impact as emerging diseases)
37	Emerging diseases (> 5 new or newly identified diseases per country by 2030)

List of External Factors that are seen as having **positive or mixed** impacts. Numbers are only for ease of reference and do not indicate an increasing level of positive or mixed impact.

No.	Expert Elicitation External Factors
38	Animal welfare increasingly valued (>50% people in rich countries agree that animals should have similar rights to humans)
39	Artificial meat (lab grown and vegetable): from < 0.25% of meat in rich countries to >10%
40	Big data used in more than 10% of agri-food businesses and agencies
41	Biotechnology: widespread use in all aspects of agri-food system – new vaccines, diagnostics and therapeutics every year
42	Blockchain used in more than 50% of animal and food traceability
43	Clean energy increases (major provider of energy in >50% countries)
44	Concentrated trade (from current 20 key global exporters to less than 10 key players)
45	Corruption declines in poor countries (from 76% people now say it is a very big problem to <50%)
46	Decentralisation of government service delivery (from 24% of government spending now is decentralised to > 50%)
47	Increasing global wealth (average GDP increases > 10% in > 75% of countries)
48	Increasing role international government organisations (considerably more influential than now)
49	Increasing trade in livestock products (from 10% of livestock products currently globally traded to > 30%)
50	Increasingly multipolar world (there will be no single power dominating the world economy and media)
51	Intensive livestock production will increase by >10% (currently 60% world pork/poultry and 15% world dairy/beef)
52	Major rejection of animal source food – billions of people become vegan or vegetarian
53	More open govt. (key dataset availability increases from 7% now to >20%)
54	Organic farming increases (from 1.1% of global agricultural land to >5%)
55	Per capita veterinary expenditure will increase (from USD21 per person currently to >USD30 per person)
56	Relative contribution of livestock on greenhouse gas will decrease by >33% relative to current levels
57	Robotics replace >20% of workforce in agri-food systems
58	Urbanisation (from > 50% of world's population now in cities to > 80%)
59	Vegetarianism increases (from 18% of the world population now to > 30% of world population)