1st Stakeholders Reference Group workshop

Answers to the questionnaire

A questionnaire was sent to the attendees and other SRG contact persons with regard to the topics that were covered in the three session of this workshop. 30 answers were received, 14 from FORESEE partners and 16 from SRG contact persons.

Organisation	Name	Country	SRG
AISCAT	Federico Di Gennaro	Italy	
Arup	Savina Carluccio	UK	x
ASFINAG	DI Karl Engelke	Austria	x
Atkins	John Owen	UK	x
Autostrade per l'Italia	Livia Pardi	Italy	
CEMOSA	Noemi Jiménez Redondo	Spain	
CEMOSA	Francisco Javier Morales	Spain	
CEMOSA	Jose Solis Hernandez	Spain	
Eiffage Kier Joint Venture	Adrian St.John	UK	x
ETHZ	Claudio Martani	Switzerland	
ETS (Basque Railways)	Josu Rodríguez Duque	Spain	x
Federal Railways SBB	Nicolas Ackermann	Switzerland	x
Ferrovial Agroman	David Delgado	Spain	
Future Analytics Consulting	Sheryl Lynch	Ireland	
Highways England	James Codd	UK	x
Highways England	Stuart McRobbie	UK	x
Ifsttar	Andre Orcesi	France	x
Infraestruturas de Portugal	Rodrigo Dourado	Portugal	
Network Rail	Stephen Brooks	UK	x
PIARC	Miguel Caso Flórez	France	x
Rijkswaterstaat	Sander Borghuis	The Netherlands	x
Rina	Fabio Bolletta	Italy	
Road Directorate	Jerónimo Vicente	Spain	x
Trafikverket	Johan Jonsson	Sweden	x
Transport Infrastructure Ireland	Billy O'Keeffe	Ireland	x
Transport for London	Mehdi Alhaddad	UK	x
Universidad de Cantabria	Alejandro Roldan	Spain	
Universidad de Cantabria	Daniel Castro-Fresno	Spain	
University of Edinburgh	Boris Gailleton	United Kingdom	
WSP Spain	Victor Centeno	Spain	

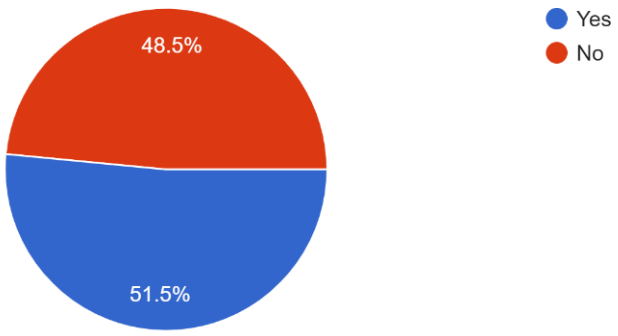
This report just collects the received answers that will be taken into consideration by FORESEE partners involved in WP2 on Data acquisition, collection, integration and management system.

1st session

Satellite SAR monitoring

Have you ever used InSAR direct or indirectly for any of your projects? If not, has any other team or project within your organisation? If so, please discuss with them the questions below.

33 responses



If you have not used InSAR or you are not very familiar, please let us know your thoughts about the technology for civilians from the description above

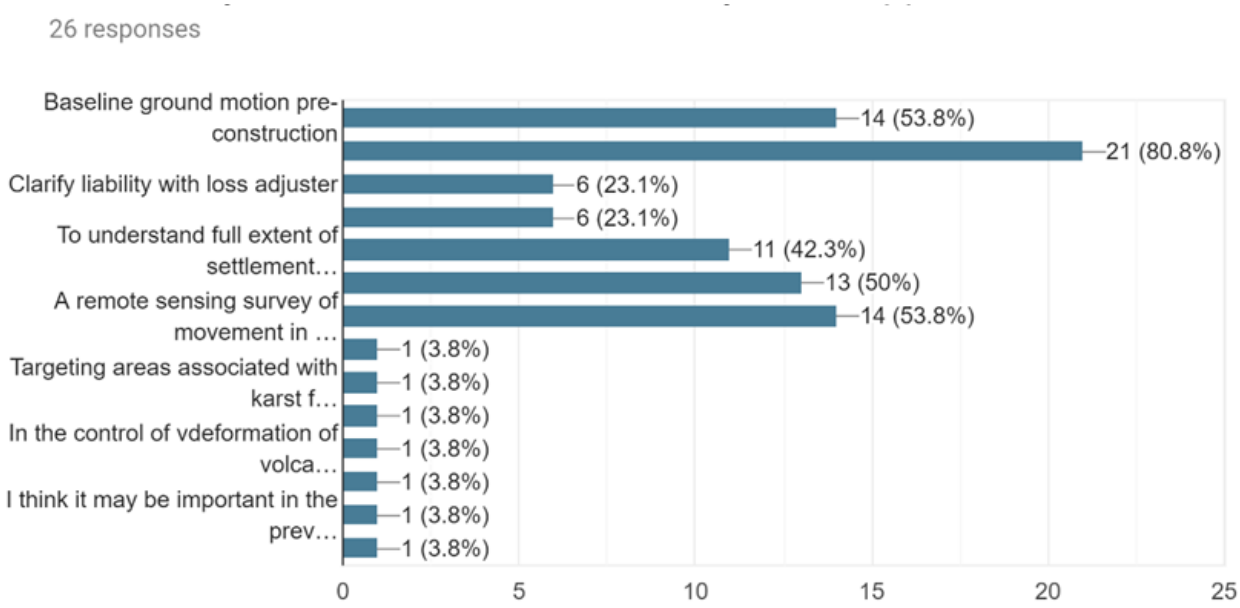
- It would be interesting
- Look like it has great potential
- It could be extremely helpful in relation to monitorize unstable slopes, to measure construction settlements and to foresee potential risks in transport infrastructures.
- We have reviewed InSAR but not yet found it suitable for our challenge
- Yes I did.
- There is no "description above" but my understanding is that this technique can be very interesting for precise monitoring of infrastructures.
- Our company used it this technic one time, to check movements before the tunnelling construction.
- It should be implemented as a tool to better monitor and plan intervention
- Technology via satellite to measure movements
- I think it could be very useful to obtain precise and broad data about civil infrastructure
- Not sure
- InSAR seems a promising technology for long term structural monitoring.
- I don´t know, we used laser scans. But InSAR sounds as an alternative
- I think this technology is interesting but not suitable for accurate monitoring activities

How is InSAR data used in your organization?

- InSAR data are used for the identification and monitoring of the areas in which the infrastructure is located. InSAR data are used for designing interventions and new constructions
- We worked with satellite data from Telespazio for FORESEE project
- As part of a research project on the national road network, InSAR was used to examine subsidence in areas of karst limestone.
- InSAR has been used in a number of research projects and site trials relating to the remote inspection of geotechnical assets to develop a better understanding of condition and potential for deterioration, specifically focusing on ground movement and ground saturation.
- It is not
- It is not currently used.
- It is currently technology we see on the horizon at the moment.
- Our company have used it twice. The first to check the extent of the subsidence o a plot over a tunnel; and se second we used as a baseline ground motion preconstrution.
- Mostly we are carrying out R&D projects to try and use INSAR technology to complement tradition surveying activities
- Not used
- Research purposes
- No use so far
- In an attachment of Risks
- It has been employed only occasionally
- It has been looked at in research work to ascertain its capabilities for monitoring condition of infrastructure assets (bridges, roads, other associated assets)
- Mainly for monitoring purposes, (de-)selection of points for in-situ measurement
- Currently it is not used, it is still under evaluation
- No used
- For detecting ground movement caused by civil engineering works (tunnelling, excavation, etc)
- Not used yet.
- InSAR has been used to validate and assess movements cause by Crossrail work on nearby assets. The use of InSAR has generally been reactive within TfL (when there has been a need to validate/confirm movements and their extent and magnitude) .
- Not currently routinely used
- SBB started to use InSAR for Natural Hazards. We are now currently starting to use the technology in other use-cases (earthworks, bridges, tunnels, etc.)
- R&I activities in Connection to large infrastructure projects
- Not used

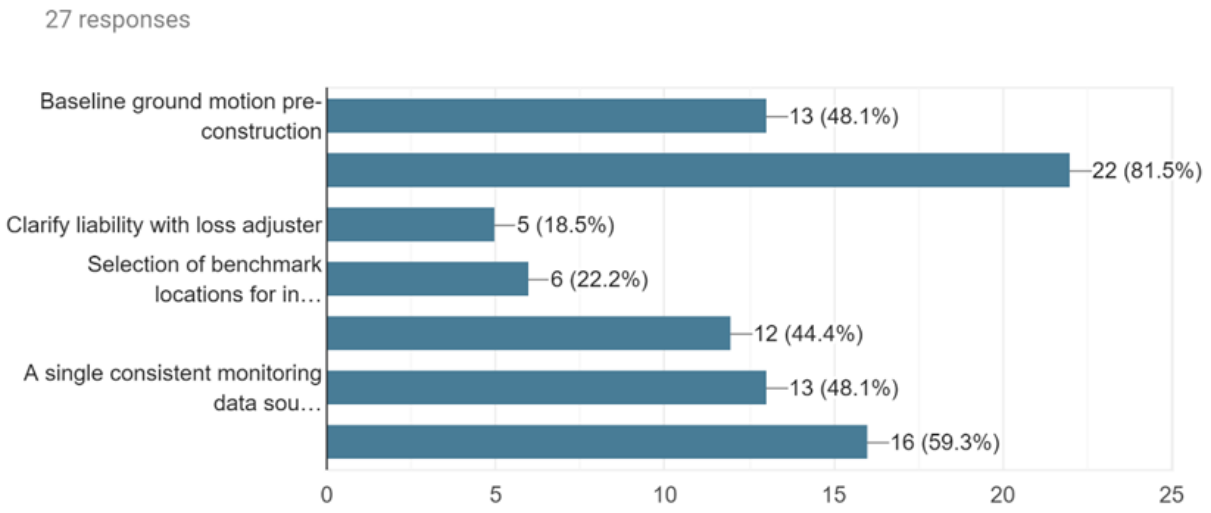
Could you associate its use with any of the applications listed below?

- Baseline ground motion pre-construction
- Long term monitoring after construction
- Clarify liability with loss adjuster
- Selection of benchmark locations for in-situ
- To understand full extent of settlement trough
- A single consistent monitoring data source for the entire extent of the infrastructure
- A remote sensing survey of movement in difficult or inaccessible areas
- Other

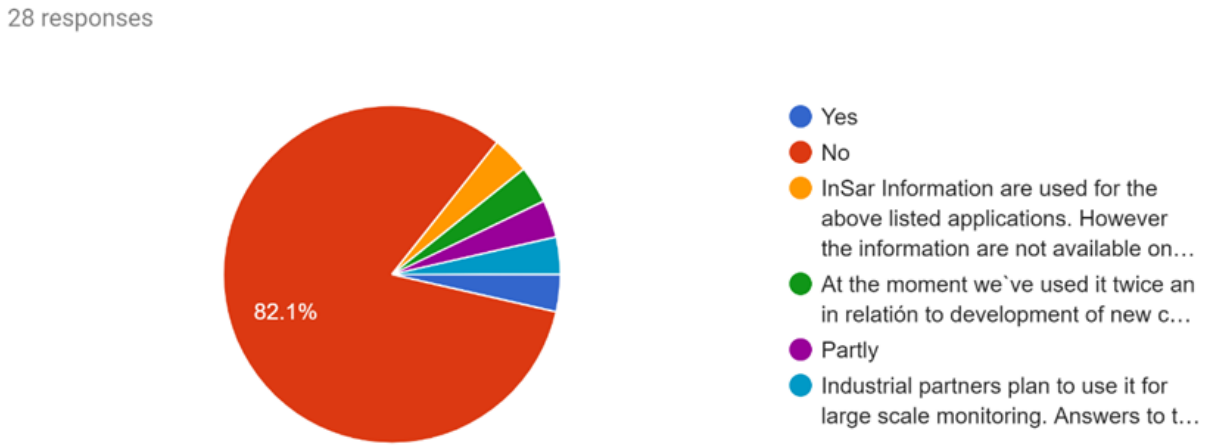


Which of the applications will be relevant to meet your monitoring goals?

- Baseline ground motion pre-construction
- Long term monitoring after construction
- Clarify liability with loss adjuster
- Selection of benchmark locations for in-situ
- To understand full extent of settlement trough
- A single consistent monitoring data source for the entire extent of the infrastructure
- A remote sensing survey of movement in difficult or inaccessible areas



Is InSAR integrated into your systems?



If not, please explain how InSAR information is used. Please, let us even know if it has been delivered but not used

- None of us work with this technology
- Not used
- Research only
- InSAR data has been used on isolated sites and projects. We are aiming to integrate an InSAR ground motion layer into our geotechnical asset information system but need to determine which InSAR sensors and satellites are most appropriate for our purposes, and also how to display that data in a GIS type environment.
- It is not
- As far as I know, InSAR information is not used nor delivered in our organization.
- Sentinel InSAR does not have the necessary spatial resolution we require.

- Currently we are studying different uses in the construction industry
- Not used
- As a database
- By the moment it's only used to set de baseline before the construction
- Has been looked at in research work, but not used operationally
- Moving from innovation / pilot phase to implementation phase
- At the moment InSAR information are not used
- Not used
- On a case by case bases and commissioned through supply chain
- Not currently used
- We do not use InSAR in a systematic way. The technology is not yet known in our company.
- In our case it is not integrated. This is not something that is done on a regular basis, but in our case only as a pilot R&I
- Since we do not use InSAR, we also do not use InSAR Information. Our elevation model was generated from laser scans
- Not used

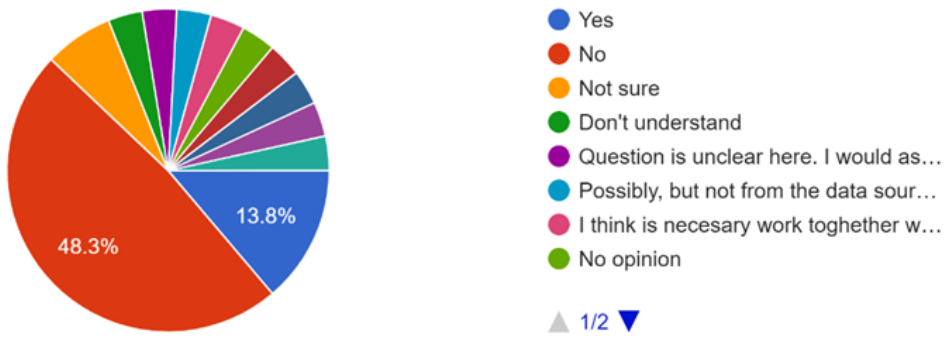
Are InSAR data outputs helpful for the infrastructure management challenges? Explain how

- Yes. In particular for an improved characterization of the infrastructure and its surroundings (i.e. identification of risk prone areas)
- The InSAR data can provide significant information to determine risk zones.
- Yes, not sure how yet
- Predicting embankment failure and areas of the network at risk from subsidence
- Early indications are that InSAR has a lot of potential with regards to long term remote asset monitoring, subject to selection of the correct sensors and satellites and them being cost effective.
- I assume it can be but I've never worked with InSAR.
- I really think so. It can be extremely helpful for the monitorization of unstable slopes, the measure of construction settlements and also the management of the whole infrastructure including risk assessment.
- We've only found Sentinel derived InSAR to be mildly useful for our mining teams.
- I actually don't know. We are studying the possibility to use this technics in the railway network maintenance.
- Still under assessment but we think it will help to identify critical areas and focus the efforts on them
- I do not know, never tried it
- We have used it to develop a risk attachment.
- Yes I think may be useful in the early warming of slope slide

- I hope so. i am interested in road condition monitoring to look for changes in surface shape and texture.
- Yes, the data serves as an information source that supports decision making
- The use of InSAR can potentially provide greater knowledge of extent of subsidence boundaries and provide indicators to potential catastrophic collapse by analysing SAR data against periods of known rapid collapse of ground. InSAR data can be used as source of additional info for a better comprehensive monitoring strategy
- To measure movements, settlements or any failures in different infrastructures
- Yes. Quasi-continuous precise monitoring and prediction (after data analysis)
- As per 2.1 above
- InSAR data outputs are helpful for history of deformation or large scale, mostly surroundings or landscape monitoring of a structure. Can be relevant for a city wide construction project.
- In principle they are. The industry needs to do more to understand capabilities and limitations
- Useful for understanding long term ground movement trends for regional rural areas and to remotely monitor earthworks assets provided a sufficient number of reflectors is available
- Yes, Satellite InSAR provides a synoptic view and allows us to look at the past. Ground-based InSAR provide us high spatial resolution at a smaller scale for Dams, slope monitoring, etc. We may test car-borne or UAV-borne InSAR systems.
- It certainly is. This technology should be standard and integrated not only into construction projects, but also into asset management systems.
- We use elevation models in the planning phase of infrastructure projects
- No, in my opinion not suitable for accurate monitoring activities and costly to implement when compared with traditional methods.

Do you think that just surface movement from InSAR direct output data (a point cloud dataset with its metadata), is enough to confront those challenges?

29 responses



Is satellite monitoring data reaching industry needs? If not, explain why

- Not for our industry yet as it seems too focused on urban areas.
- Yes I do. But it is necessary to improve
- We think it will meet the needs once traditional surveying is not necessary
- I think so
- Yes
- I am not sure.
- It is getting there
- Yes
- Cost is a key deciding factor for stakeholder uptake of this technology
- Yes
- Not yet although maybe in certain applications such as in landslides
- Don't know
- At this date, it is still complicated to sell InSAR technology because accuracy of final data is complicated to predict.
- InSAR cannot provide a full answer but it certainly provide additional information which can potentially be valuable and irreplaceable
- Too expensive, laborious data processing and specialist skills needed to interpret results
- Satellites are one component of a monitoring system. It provides the hotspots at a large scale. Further details of the hotspots should be measured in-situ or with UAVs.
- Just using raw InSAR data limits its use. Advanced algorithms for data interpretation and image processing should be developed further and connected to traditional engineering disciplines.
- Data and processing costs

Please list any limitations you see in the technology

- The rate of acquisition of data which hinders the use of InSar for alerts
- Cost
- Processing
- Cost. Orientation of infrastructure relative to satellite orbit. Vegetation. Data collection frequency.
- Filtering relevant information
- The necessity of managing a huge amount of data. Efficient filters and data selection applications will be necessary.
- Relies on reflectors, there are insufficient reflectors on rural sections of railway and adjacent hillsides.
- It is not utile for instant rock movement, or in vertical climbs in narrow trenches
- Frequency of data collection, price and accuracy
- I am not sure of it is usefulness in very wooded areas and very narrow trenches

- I require sub-millimetre shape information on the shape and texture of roads which is hard to achieve from satellites.
- Uncertainty in what is the exact source of the persistent scatters. Dependency on the RS data provider...
- Quality of measures
- Geotechnical and geomorphology data but I think the aim would be to merge both technologies
- Cost and speed of data acquisition
- Sampling rate; Deformation in line of sight of satellites vs. 3D displacements; Unpredictable loss of correlation of some points ; Hard to predict accuracy.
- Monitoring of earthworks, frequency of monitoring, ampleness of 3D movements, complication in understanding the fundamentals, etc
- Limited use in rural areas
- No displacement measurements North-South. Loss of coherence with vegetation. Costs of high resolution satellites.

What has traditionally been missing in the industry for Instrumentation and Monitoring?

- Budget for example
- A holistic approach. The integration of different techniques and models for managing infrastructures
- Inter-operability
- Large scale monitoring of embankments
- Reliable automated remote monitoring.
- Automatic filtering of relevant information from a mass of data
- The availability of data during the long term. The acquisition of monitoring data does not usually last in the long term and it is difficult to compare with "old" or preconstruction data.
- We use in-situ monitoring and no form of remote sensing can provide an equal view of our infrastructure at sufficient intervals, cost effectively.
- The control without invasive techniques
- In many occasions there is no allowance for I&M in construction projects.
- The possibility of analysing a very wide area without having to Access the property
- Unknown
- Thorough mutual understanding of producer and customer? What are limits in instrumentation and monitoring and what are the requirements of the customer...match or no match? In the end maybe a lack of cooperation?
- A enough number of measures
- Robust, reliable, remote, low cost monitoring with the appropriate level of accuracy
- Fast and reliable novelty detection approach based on dense monitoring with fast and reliable extraction of the effects due to environmental conditions"
- Best practice guides on selecting the optimum instrumentation

- A way to proactively and remotely monitor assets
- Integration of satellite imagery
- The Construction industry is very conservative. Although benefits exist, profit margins are low and that has a direct impact on introducing new ideas / technology.

Which gaps do you think InSAR is covering and not covering?

- Long historic records - wide areas monitoring
- Not sure
- Research
- Unsure at this stage, due to not having undertaken complete trials on all available InSAR datasets; this can be cost prohibitive
- It can provide extensive and constant infrastructure monitoring
- Covering> Availability of comparable data trough extended periods of time. Not covering> This technology is not currently broadly used.
- InSAR doesn't work everywhere across the UK. The industry needs to be more open and honest as to where it works well and where it doesn't.
- I think it's very helpful for the hillsides control near of railways, but I have doubts about their utility in vertical slopes or in leafy areas
- Covers a general overview and qualitative assessment. Accuracy and availability of real time data are not covered.
- The possibility of covering large areas of study
- Unknown
- InSAR closes the gap of a nationwide overview of deformations.
- Frequency of records
- Not sure
- Large scale dense monitoring : covered by InSAR; Long term monitoring and Historical data : covered by InSAR (only lower resolution free services); Absolute displacement data : not covered by InSAR; Daily phenomenon : not covered by InSAR"
- It is covering the areas that cannot be accessed otherwise. It can go back in time. It can cover a larger area. However, it is limited to what already reflects unless reflectors are installed for future monitoring
- Good data frequency, good resolution for commercial satellite, availability of historical data. For gaps pls see above. It provides spatially and temporally continuous monitoring. It still has some limitations (see above).

2nd session

From satellite datasets to "in house" satellite monitoring system

Is there a need to develop a digital tool/system fed by satellite monitoring data and other relevant sources to provide efficient and intelligent answers for infrastructure and asset management?

- There is but perhaps the priority is to provide robust solutions first
- Yes I do. I think that this kind of tool improve the usefulnes
- There is a need to develop digital systems/tools for asset monitoring, whether it is fed by satellite data or on site devices is a matter of cost an accuracy of the data
- Yes it is. It is the only tool that can analyze so many parameters throughout the space.
- Yes
- Yes
- Yes
- Yes
- If satellite monitoring can provide additional and reliable information in addition to traditional ground monitoring, there is an interest to develop such techniques.
- There is actually a need for state assessment of infrastructure networks. Personally speaking I consider that satellite monitoring should be complementary to other type of inspections/monitoring.
- Yes, sure, and I believe the need and complexity can range from a simple viewer or portal to intelligent decision support systems
- Yes
- Yes
- No, in my opinion.
- Yes, a map layer that can share across platforms would be useful. It must be capable of being integrated into existing asset management systems.

Is the Earth Observation industry having to adapt to the ways of Transport sector?

- Certainly
- I think they have to do
- The data gathered nowadays provides a rather qualitative assessment to a very high cost. For these technologies to be useful they should be more accurate so they can better help traditional surveys, and cheaper so the value added/cost ratio is attractive.
- Of course, it is necessary that the data adapt to the idiosyncrasy of the sector such as the frequency of availability or the immediacy of the data.
- Yes
- Yes, monitoring linear infrastructure is not the same as using InSAR for construction monitoring in urban sites.

- Yes
- Yes
- Transportation sector needs to be able to make decisions fast, which is maybe still not feasible with current earth observation industry.
- I think it definitely is. It would be necessary to have access to a continue stack of historical images/data. Data collection only on demand is not very useful.
- No, not necessarily, I believe that through cooperation we can design and launch instruments that can be used for infrastructure monitoring
- Yes
- YES, to develop specific solutions
- I think so
- It needs to - its pricing systems cover large areas and are not effective for linear infrastructure.

Should the transport sector adopt some of the global digital approach from Earth Observation solutions?

- Not sure if this is practical at this stage due to the limitations in the platforms of the transport clients
- If they know our need they improve the work
- Maybe in the future when the cost decreases, at the time we do not think that is an option.
- In my opinion it would be interesting.
- Yes
- Not clear about the question
- Yes
- Yes
- Not enough knowledge in this field to provide an answer.
- I think so. Earth Observation solutions are (or could be) a very useful tool.
- See my answer above
- Definitely
- Yes
- Maybe, if suitable to accuracy requirements
- Question not understood - not sure what the global digital approach is.

Which would be the best approach?

- A 3rd party provide consultancy services
- The one described in 2.1
- The acquisition of real-time data outputs to anticipate different natural (meteorological and geological) and anthropogenic risks
- Centralised processing offering deliverables

- Best approach would be a shared database of processed InSAR data available to infrastructure owners and operators to manage their asset.
- Satellite InSAR is certainly the number one technology. Then, it comes multispectral satellite imagery. SAR backscatter could also provide useful information. The spatial resolution of free satellites imagery is still limited.
- Dialogue
- Not enough knowledge in this field to provide an answer.
- Integrate Earth Observation data with the rest of monitoring results into an assessment tool.
- Cooperation
- Pooling of resources among different stakeholders to build a comprehensive database to manage assets
- Cooperation between sectors is the best option
- I do not know
- Question not understood - what approaches?

What are the advantages of each approach?

- We do not think there is an option for transport sector to adapt at the time, due to budget constrains
- A quick and efficient response would improve the resilience of infrastructures.
- Most of the client would not have required computer infrastructure to process the amount of data
- There is only one way, talk and meet.
- Not enough knowledge in this field to provide an answer.
- Control costs
- Both have to adapt
- Question not understood - which approach?

Are any of the systems described during the workshop (Satellite-SHM, GIS hotspot risk mapping and impact ranking, Landslide Failure Prediction and SUMMIT) meeting the challenges of infrastructure monitoring you face or envisage? If not, what is missing?

- They are in the right direction, but the impression was that these are yet in research stages
- I think that it is not possible only one tool. I think it's necessary a GIS tool that can integrate some of them
- all of them are useful to a certain extent, but we consider most of them provide with limited information with a very high cost
- These tools are really useful but I would add others such as the implementation of all this in the same software that also includes other tools such as synchronization with real-time meteorological models or with traffic data.

- Not Applicable
- Clear guidance on how to use Sentinel-1 and commercial satellite outputs for infrastructure asset management applications with use cases would be a very useful output.
- Satellite-SHM coupled with GNSS based monitoring seems an interesting solution.
- It is missing a multi-technology approach that may be able to integrant all the monitoring or test data. The technologies described are extremely focused on satellite monitoring, lacking of a more general approach.
- Yes
- Yes
- Implementation strategy
- Satellite-SHM and Landslide Failure Prediction are the most interesting solutions
- GIS hotspot risk mapping, for sure
- Not really - there is a need for a network-wide survey approach so that defects can be identified and prioritised before they become an issue. It needs to take into account the fact that most transport infrastructure is linear.

4. Will you use any of the solutions/systems described above in your project?

- Yes, if they could demonstrate that they are more economical and can improve the safety and efficiency of operation
- If they became economically competitive and once the features are proven interesting to our needs, yes, we would.
- It is possible
- Not applicable
- They look useful, however these solutions need to be interoperable with existing asset management systems already in place in the organisation
- Maybe
- Introducing these ideas on a broader scale at in Infra Manager is a challenge
- GNSS bridge monitoring is investigated currently.
- Only to obtain complementary information
- more likely not
- Yes
- Yes
- Possibly
- No
- Not yet

3rd session

Resilience Shift initiative

Do you currently use any assessment frameworks, guidelines, standards or tools for assessing or improving resilience of transport networks? What are they?

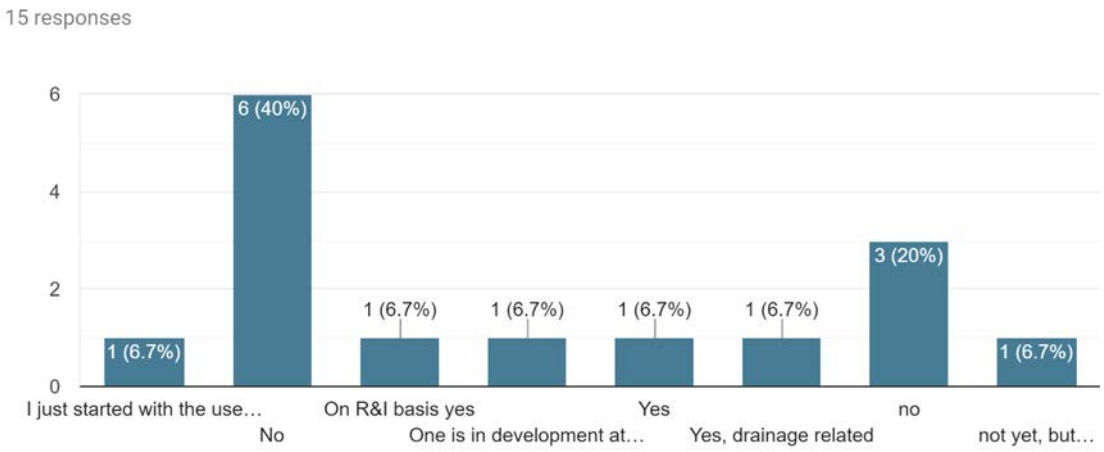
- Not personally
- No, we don´t
- No, we are only carrying out R&D related projects related to resilience
- Yes, the GIS hotspot risk mapping and impact ranking
- Internal inspection guidelines
- No
- Some references: M. Bruneau et al., "A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities," Earthq. Spectra, vol. 19, no. 4, pp. 733–752, 2003. N. J. Mansfield, "European Directives," 2018. C. Of, T. H. E. European, G. Paper, O. N. A. European, P. For, and C. Infrastructure, "No Title," 2005. RESILIENS consortium, "Methods for Resilience Assessment," p. 138, 2016.
- No
- Not yet, but we are working on it
- Yes, we use earthquake proof construction standards, flood risk and climate change resilience frameworks and guidelines in The Netherlands
- Yes - flood modelling, landslide susceptibility maps, Extreme weather response strategy, Embedding climate factors into designs (increase rainfall), Shift to SUDS systems for quality and quantity controls.
- No
- We are developing our own Resilience Assessment Framework Tool (RAFT) for use in determining inspection and maintenance programmes for geotechnical assets. This comprises two parts i) understanding risk ii) improving resilience, including an online tool that can be accessed both internally and externally, by our supply chain.

Do you see any gaps where there is currently no available tool for assessing or improving resilience of transport infrastructure but you wish there was?

- More awareness is a first step - tools can follow after
- Mainly drainage systems, but resilience is generally a new topic that should be further studied
- Yes, software that implements in real time all the risks that may affect the transport network
- Definition of resilience itself often leads to different interpretations
- Yes, a common and approved method/toll would be nice

- Maybe in extreme weather events (storm, rainfall), but also for long droughts
- Subsidence, impacts of karst.
- Tools could help in assessing resilience and improve operation of networks
- Yes - a cross asset, network-wide tool would be useful. A challenge for us is understanding and scoring network criticality, which is an essential part of a resilience framework.

Have you ever created a tool for assessing or improving resilience of transport infrastructure for yourself or others to use?



Where do you see alignment between the RS and FORESEE?

- FORESEE provides an additional tool for assessing resilience
- Very similar project in general
- Data collection through RS is one of the tools to assess the resilience of transport networks.
- RS seems to work on general concepts which could be used to better highlight the needs associated with resilience.
- Deformation monitoring, climate modelling based on RS data, extreme weather prediction through satellite information...land use change, plenty!
- The approach is similar

Where are the differences?

- RS is a process while FORESEE provides a tool
- Very similar project in general

- How to make the communication infrastructure more resistant to extreme events is not limited only to data collection. Also the creation of methodology, actions or structures that are able to hold the functionality of the infrastructure after an extreme event.
- As mentioned before, RS is more on general concepts and FORESEE on the development of technological solutions.
- Possibly in the choice of the indicators to measure resilience
- Not sure.

How can the FORESEE outputs advance implementation of resilience and the knowledge generated by the RS complement FORESEE?

- As above
- The tools we create may help contrast outputs where they overlap or can be complementary
- Creating a database robust enough to be able to base decision making. It would also serve to classify by priority the different measures to be taken.
- The problem is not the results as they are. The results are great. The problem can be found at the InfraManager, and it is a way of thinking that needs to be changed.
- The RS should identify some real situations on which the FORESEE solutions could be applied.
- When the lessons learned are shared and implemented by the FORESEE members (>60 people from >14 countries?). 2. The RS solutions that prove valuable to resilience must lead to new guidelines and practice
- FS outputs could be used to validate the RS