Data collected and summarized from:
Sherman, I. 2007 Twelve Disease that Changed Our World, American Society for Microbiology, USA
*Source of virus debated, hence used prevalent name of disease, **SARS-Cov1, ***SARS-Cov2

Jutla and Colwell, 2021
- **Overall framework**: What are your goals and related activities for 2022-2023 (e.g. series of workshops, specific product or dashboard, collaborative paper)? What are your measures of success?
  - Dashboard for summary of findings including expertise in the community
  - Collaborative Position Paper

- **Audience**: Who represents your main audience (e.g. collaborators, end-users, other stakeholders)?
  - Collaborators -> Stakeholders -> End Users.
  - We are at Collaborator -> Stakeholder stage. We are hesitant to involve end users at this stage since it the coherent message is still in progress.
  - Dashboard from framework will serve as a connector for establishing collaborations

- **Partnerships**: Do private partnerships exist in your activities, and if not, how may they be explored? Are there any other GEO groups from the International Work Programme that may offer a successful partnership?
  - No partnerships (private) are explored at this stage.

- **Challenges**: If you anticipate any major obstacles, how do you plan to address them?
  - Dashboard and Position paper requires someone on short term so that this activity can be managed collectively.
  - One idea is to have a post doc specifically hired (for a year?) for this activity.

- **Other topics**: How can CoP Co-Chairs and members continue to support your Small Work Group activities?
  - Our group remains cohesive (at this stage!)
<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Species</th>
<th>Illness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacteria</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Shigella</em></td>
<td><em>S. dysenteriae; S. flexneri</em></td>
<td>Gastroenteritis; Dysentery</td>
</tr>
<tr>
<td><em>Vibrio</em></td>
<td><em>Vibrio cholerae</em></td>
<td>Cholera</td>
</tr>
<tr>
<td></td>
<td>Noncholera <em>Vibrio spp.</em></td>
<td>Gastroenteritis; wound infections; septicemia</td>
</tr>
<tr>
<td><em>Salmonella</em></td>
<td><em>Salmonella typhi</em></td>
<td>Typhoid</td>
</tr>
<tr>
<td><em>Mycobacterium</em></td>
<td><em>M. avium complex; Non-tuberculosis Mycobacterium (NTM)</em></td>
<td>Respiratory illness; skin infections</td>
</tr>
<tr>
<td><strong>Viruses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Reoviridae</em></td>
<td><em>Rotavirus</em></td>
<td>Gastroenteritis</td>
</tr>
<tr>
<td><em>Caliciviridae</em></td>
<td><em>Norovirus</em></td>
<td>Gastroenteritis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geophysical Parameter</th>
<th>Species</th>
<th>Reference</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td><em>Shigella spp.</em></td>
<td>70–74</td>
<td>Positive association with ambient temperature and sea surface temperature (SST).</td>
</tr>
<tr>
<td></td>
<td><em>Vibrio cholerae</em></td>
<td>6,12,76–79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Noncholera <em>Vibrio spp.</em></td>
<td>6,21,14,41,42,80–83</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Salmonella typhi</em></td>
<td>84,85</td>
<td></td>
</tr>
<tr>
<td>NTM</td>
<td><em>Norovirus</em></td>
<td>87–89</td>
<td>Varies between positive and association with temperature, depending on species and geographic region.</td>
</tr>
</tbody>
</table>

Usmani et al., (under review)
<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Precipitation</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rotavirus</strong></td>
<td>90–94</td>
<td>90–94</td>
</tr>
<tr>
<td><strong>Vibrio cholerae</strong></td>
<td>75–77.5</td>
<td>75,76</td>
</tr>
<tr>
<td><strong>Noncholera Vibrio spp.</strong></td>
<td>85,38,41,42</td>
<td>85,38,41,42</td>
</tr>
<tr>
<td><strong>Salmonella typhi</strong></td>
<td>84,88</td>
<td>84,88</td>
</tr>
<tr>
<td><strong>Norovirus</strong></td>
<td>85,96</td>
<td>85,96</td>
</tr>
<tr>
<td><strong>NTM</strong></td>
<td>86</td>
<td>86</td>
</tr>
<tr>
<td><strong>Shigella spp.</strong></td>
<td>70–73</td>
<td>70–73</td>
</tr>
<tr>
<td><strong>Rotavirus</strong></td>
<td>70–94</td>
<td>70–94</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td><strong>Shigella spp.</strong></td>
<td>70–73</td>
</tr>
<tr>
<td><strong>Vibrio cholerae</strong></td>
<td>75,76</td>
<td>75,76</td>
</tr>
<tr>
<td><strong>Salmonella typhi</strong></td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td><strong>NTM</strong></td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td><strong>Noncholera Vibrio spp.</strong></td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td><strong>Rotavirus</strong></td>
<td>90,91,93,100</td>
<td>90,91,93,100</td>
</tr>
<tr>
<td><strong>Norovirus</strong></td>
<td>87,96,101</td>
<td>87,96,101</td>
</tr>
</tbody>
</table>

- Negative association with temperature.
- Positive association with precipitation.
- Vary between positive and association with precipitation, depending on species and geographic region.
- Vary between positive and association with precipitation, depending on spatial scales.
- Positive association with relative humidity.
- Negative association with relative humidity.
- Association with humidity varies spatially between negative and no association.
- Absolute humidity is more critical than relative humidity for the survival of norovirus.
Agenda for Small Working Group (Infectious Diseases):
1: Establish database on earth observation use in understanding modalities of infectious diseases
2: Discussions on format of meetings
3: Ready for (volunteering) a position paper?
4: Health for all: Health and Environmental Equity through earth observation

Meeting minutes

For point 1:
Students from various labs can work on it, but this is a huge undertaking - and may need resources for updating this system. The database is critical but will require depth and breadth for consistency and coverage of infectious pathogens and associated diseases.
A post-doc at NASA or NOAA can help - and see if such resources can be developed.
Perhaps a small write up can be circulated to students and they can volunteer?
For data inputs: think of developing a web form.
Database should have query functions - such as studies for hypothesis, or application or mixed ones.
Broader questions need to be defined in terms of who will be the audience to use this data.

For point 2:
Perhaps a quarterly meeting format is acceptable at this stage.

For point 3:
A need for a review article that can summarize history of EO in predicting various infectious pathogens (or develop proxies for emergence of pathogens).

For point 4:
No discussion yet - will address in next meeting
SUGGESTIONS FROM LAST MEETING

- Experimental resources on where expertise exist.. Mapping, monitoring and following up with people, resources
  - This would be a huge task- but doable.
    - We have initiated efforts to achieve this task
    - Request all who are interested to complete the spreadsheet shared earlier
    - Link to map
      - https://remote-sensing-infectious-diseases-ufl.hub.arcgis.com/
    - Link to database
      - https://uflorida-my.sharepoint.com/:x:/g/personal/ajutla_ufl_edu/ETeOGJNB0J5ItQrBqVoxIIBFxV_YoMdCMnd2qQABRrIYg?e=qUFa2m

- Showcasing our work for COP- products and services developed, limitations and further improvements.
  - Schematics being chalked out
Earth Observations and Infectious Diseases
Antar Jutla & Members of GEO Infectious Disease Small Group
University of Florida, Gainesville, FL

Abstract

Improve prediction and prevention systems for environmentally-sensitive infectious diseases to help reduce risks for human health by application of Earth Observations (EO) to enhance decision-relevant risk monitoring, with particular focus on underserved communities.

1) Develop a generalization framework for incorporating climatic and environmental data for enhancing predictive and decision-making mapping capacity to serve as the EO backbone for water- air- and vector-borne diseases; and

2) Develop platform for the monitoring and prediction of emerging pathogens and toxins risk in marine and coastal environments coupled with critical EO-derived coastal and inland water quality parameters.

Examples of application of EO

- Cholera
- Rift Valley Fever
- West Nile Virus
- Zika

Discussion points

- Identification of critical EO and prediction requirements for health, specifically for evolutionary aspects of pathogens.
- What data, surveillance systems and tools are currently being used?
- What data and surveillance systems and tools are required to be able to measure risk of disease outbreak in future?
- Enhance integrated modeling of disease risk or prediction of environmental drivers of disease and other health outcomes.
- Understand links between environmental and climate change, food quality and nutrition, and health.
- Predict when, how, and where diseases will emerge and identify the populations most at risk and most vulnerable
- Earth observation and health equity justice
- Communication across aisle (other disciplines)
COVID-19 provided opportunity to explore and advance integration of earth observations with epidemiological modeling. This is because there is a public conscience and attention on what these models can (or cannot) do. This can also provide a carving space for complementary expertise in geosciences.

- Need to understand evolutionary processes—specifically for viruses.
  - Immune systems and integration of animal science aspects (especially for zoonotic diseases)
  - Resolve scale issues of where pathogens are and what earth observations can provide.
  - EO cannot be useful for all infectious pathogens.
  - Need to develop comprehensive understanding on mutation of viruses so that proxy EOs can be identified.

- A need for a space for creation of actionable knowledgebase within geosciences community. Perhaps a policy document need to be prepared.

- Can EO be used as personal or personalized medicine?
  - May be both but needs quantification.

- How can EO based methods and algorithms can be communicated to “the other side”—public health and medicine? Is there sufficient trust or effective communication channels?

- A need for a review article that can summarize history of EO in predicting various infectious pathogens (or develop proxies for emergence of pathogens). While all agreed that this would be a good idea, yet this would be a mammoth task and we will continue discussion on it in our next meeting. One of the ways to do it is to gage interest of group members and assign particular pathogen for summary. Other ways would include thinking of a possibility to discuss availability of resources in terms of a post doctoral scientist.