- Wearable Sensors for Analyzing Personal Exposure to Air Pollution
- Nghi Dam, Andrew Ricketts, Benjamin Catlett, Justin Henriques, James Madison University. 2017. Wearable Sensors for Analyzing Personal Exposure to Air Pollution.

  https://zimbra.earlham.edu/service/home/~/?auth=co&loc=en_US&id=9175&part=3

  - Includes descriptions about a wearable sensor and the components of its make.
    - Includes different air quality sensor models and the Arduino that they are built on
  - Mentions the effects of air pollution on the human body
  - Shows data on how the wearable sensor has high quality data reads but low battery life
  - Discusses plans for further research into decreasing size and improving battery life
  - Discusses plan for research into wireless connection to cellphones for real time sensing and server data gathering from sensor

  This paper describes a portable and wearable sensor that would read air quality data and store it internally on a removable micro-SD card. The sensor is made up of multiple air quality sensors that can be bought relatively inexpensively and then fixed into an Arduino Uno. The sensor runs off of a 9v battery. The paper claims that the sensors are precise and provides a graph from tests conducted with the wearable prototype versus a well-established non-portable air quality sensor. The paper concludes with mentioning the plans for further research for collogues into the wireless connection to personal smart phones for real-time sensing and data gathering.

- A Survey on Sensor Calibration in Air Pollution Monitoring Deployments
- Balz Maag, Zimu Zhou, Lothar Thiele

https://hal.archives-ouvertes.fr/hal-02861698/file/Languille_et_al_Polluscope_v2.pdf

  - Starts by discussing the short comings of high-cost stationary air pollution sensors and how many people are affected by air pollution physically
  - Discusses the various kinds of air quality sensors and how they work, also dives into their short-comings as small and low-cost sensor alternative to high-cost stationary monitoring sensors
  - Goes into detail about the various calibration techniques used to calibrate low-cost sensors to be as accurate as possible
    - Neural networks made with machine learning and other forms of calibration using control testing versus a control as well as mathematical formulas (least squares and curve fitting) showed significant improvement from the factory calibration on low-cost sensors
  - Discusses how the optimal array of small low-cost sensors is an open question still because of the cross sensitivities
  - States that recalibration is needed often within the span of a couple of months and is necessary – could be a potential issue for feasibility and practicality
  - Discusses various approaches to recalibration using different times of the day for different compounds (O3 is usually very low between 1AM-4AM) or rendezvous calibration using the same air between two sensors (one being a reference sensor) that are in close contact
  - Mentions E-noses and their transfer calibration technique
  - Discusses how the three mentioned calibration techniques could have various parts from each merged into an all-around calibration technique

This paper is about various techniques to calibrate low-cost mobile air quality sensors of various kinds. Each sensor uses one of many techniques to sense the air around it – metal oxide vs electro chemical vs particulate matter – and each of these techniques comes with its own challenges in calibrating and cross sensitivity to the other kinds of sensors in the measuring system. There are a multitude of calibration techniques that can be used to maintain the accuracy of these sensors and measuring systems – many of them using machine learning and a lot of math cross referenced to a reference sensor that is not mobile. Each technique poses its own advantages and disadvantages and that is what goes into the research to combine various techniques for the best all-around calibration technique with for a network of sensors.

- Project-Based Learning Experience That Uses Portable Air Sensors to Characterize Indoor and Outdoor Air Quality
- Jessica C. D'eon, Laura T. Stirchak, Abenen-Shepsu Brown, Yusra Saifuddin

  https://pubs.acs.org/doi/pdf/10.1021/acs.jchemed.0c00222

  - This paper is about the testing of various sensors in a network with high school students and some undergraduate students
  - This is about the process of citizen science in project-based learning initiatives to characterize and test indoor and outdoor air quality
  - Tests were ran with an air quality sensor that was capable of reading PM2.5 and smaller and was connected via Bluetooth to a monitoring app on a smartphone
  - Goes into detail about the experiment tested with one individual where their whole schedule was described and the readings
  - The experiment shows that the sensors are able to pick up on small fluctuations in air quality such as when someone starts cooking in the house or when more people show up to a house for a gathering
  - Discusses the benefits of citizen science in the realm of air quality sensors and the uses for them such as what was experimented with in this paper

  This paper is about the use of low-cost portable air quality sensors being used in an experiment to test the citizen science aspects of the sensors as well as educate the students involved. The experiment focused with undergrads and high school students where they wore the sensors for the majority of the day and in specific scenarios to test air quality. There were some very interesting findings that would need to be further investigated to figure out the root causes of the values. The sensors were put to the test and were deemed to be very accurate and useful in environments that weren't too humid, such in the bathroom with a hot shower running. The uses for these sensors in citizen science are profound and really strike at the heart of taking climate activism and personal air quality safety into the hands of the individual in order to help the whole of your community.

- In Situ Calibration Algorithms for Environmental Sensor Networks: a Review
- Florentin Delaine, B´ereng`ere Lebental and Herv´e Rivano

  https://hal.archives-ouvertes.fr/hal-02174938/document

  - This paper is about in situ sensors, meaning that they are not removed from their initial location to calibrate, and they are usually calibrated in a way that does not require human intervention
  - Discusses that one calibration system is reference system where nodes (personal sensors) would then be calibrated based off one or more reference sensors.
    - Calibration between nodes without a reference sensor is classified as blind calibration
    - Calibration between nodes where it is considered that the nodes can reference each other is considered partially blind
  - Discusses pairwise calibration where two nodes are calibrating each other and one is the reference sensor and it can be a distributed or even localized algorithm
  - Discusses macro calibration which is the calibration of the network as a whole where the connections between nodes are not used directly
  - Discusses group calibration where the pairwise and macro calibration techniques are mixed and groups of sensors defined by parameters of distance or other qualities are macro calibrated. Can be partially distributed across the network
  - Discusses various techniques to maintain calibration without needing recalibration such as constant referencing to nearby sensors to adjust calibration
  - Discusses what kind of issue calibration drift is, is it an age issue or a drift of data and the propagation of anomalous entries

  This paper is about the different calibration techniques and the growing popularity of the idea of a large amount of portable carried by people. The sensors are nodes inside of a network and their ability to maintain calibration is not 100% yet so there is a need for recalibration or some form of maintaining accuracy by some basis of reference. There were three different calibration techniques discusses with each having its own pros and cons. One of the main take-aways from this paper is that there is not enough of these sensors already in the public in order to garner a standardized comparison in the real world and not just in test environments. The pairwise calibration technique really requires a lot of nodes in a network in order to maintain calibration across a network because the nodes need to be near each other in location. The sensors would be calibrated off of a reference sensor and then the node would become a reference sensor for the next node. The macro calibration is a technique where a straight calibration algorithm is applied to the whole network. This has the con of being something that really needs a great algorithm with a lot of monitoring. The last calibration technique discussed was the group calibration where the nodes are grouped by qualities, such as location, and then macro calibrated. This has the advantage of reducing the cons of the macro and using some techniques from the pairwise calibration technique. All techniques are in situ, which means the nodes do not need to go anywhere to be calibrated.

- End-User Feedback on a Low-Cost Portable Air Quality Sensor System—Are We There Yet?
- Johanna Amalia Robinson, David Kocman, Milena Horvat, Alena Bartonova

  https://hal.archives-ouvertes.fr/hal-02861698/file/Languille_et_al_Polluscope_v2.pdf

  - Discusses the various facets of creating an end-user low-cost portable air quality sensor
  - Expresses the importance of end-user feedback and involvement in the creation of the product in order for it to have the highest customer satisfaction
  - Describes the study that was conducted using volunteers in Switzerland to carry a prototype of a lightweight portable air quality sensor
    - Was not a great sample size or sample variety
    - Describes the way that the sensor was connected to the users smartphone and how the phone was used in data gathering from its on-board sensors (accelerometer, etc.)
    - The users/test volunteers were generally interested in the idea of the portable real-time low-cost air quality sensor, but had a lot of feedback on how to improve the product. Generally, just technological/coding issues with the measuring system and app
    - Goes into great detail about all the short-comings of the experiment with volunteers and how their monitoring system prototype could be improved
  - Discusses in large the suggestions from the volunteers in the study on how to improve the measuring system

  This paper is about the study done with volunteers to test a prototype of a small low-cost portable/wearable air quality sensor that was Bluetooth connected to an app and the app was synced with a server that collected data and ran programs to visualize data (not on the app). The bulk of this paper is purely suggestions on what would make a good study experiment for a prototype and a lot of desirable and useful features of a small low-cost portable air quality sensor, app, and server measuring system.

- A Methodology for the Characterization of Portable Sensors for Air Quality Measure with the Goal of Deployment in Citizen Science
- Baptiste Languille, Valérie Gros, Nicolas Bonnaire, Clément Pommier, Cécile Honoré, Christophe Debert, Laurent Gauvin, Salim Srairi, Isabella Annesi-Maesano, Basile Chaix, Karine Zeitouni

  https://hal.archives-ouvertes.fr/hal-02861698/file/Languille_et_al_Polluscope_v2.pdf

  - Goes into a lot of detail on the thought and study in the experiments for this paper
  - Discusses methods for which sensors were chosen and why
  - Discusses challenges faced and methods for getting through the challenges
  - Discussed in great detail the tests for the monitoring system being developed and how they were working to make the results as clear as possible
  - Goes into a lot of detail of the results of the experiments to test which sensors they were going to use in their project
    - Doesn't actually say which sensors had which results, classified with alphabetical letters
  - With the selected sensors, the tests results were very thoroughly described while it did not ever mention the actual sensors names in the section describing the sensors abilities in testing
    - It did actually say the sensors names later – did not associate them with the test results, just said they were reliable and passed the tests
  - Goes into detail about the benefits and short comings of each sensor and its usability in the 'real-world' production

  This paper is about the testing and ability of multiple sensors that could be used in a project like the one I am proposing and going to be researching on. The sensors went through many thorough and rigorous tests that were described in the paper. The sensors that came out on top I will have to research more to see if there are newer versions of the sensors or better ones because this paper is from 2018. The paper is a good example of how to test sensors and set up the preliminary hardware choices for the portable air quality measuring system. It does not give any real detail about further research.

- An Analysis of Polluted Air Consumption and Hazards on Human Health: A Study Towards System Design
- Anish Singh, Harshita Joshi, Amritansh Srivastava, Raja Kumar, Nishita Hasteer, Amity Univeristy, Uttar Pradesh

https://zimbra.earlham.edu/service/home/~/?auth=co&loc=en_US&id=9175&part=2&view=html

  - Discusses the various health detriments of air pollution.
  - Lists study resources that were cited for this paper
  - Discusses the basics of the system being designed
    - Sensor models and wifi module listed
    - Discuses how it is a all-in-one portable monitoring system that connects directly to wifi and your phone connects to the data servers that the monitoring system is connected to for real-time analysis
  - Doesn't really go into the actual system architecture besides very general design

This paper describes many things about how bad different things in the air are for humans to breath. It also goes into basic detail of the structure of the portable air quality monitoring system that would be used. The detail is purely written without any actual visualization on the hardware. The monitoring system would send data from the time it is being used to a cloud from an onboard wifi module and then you would have to access that data on your smartphone. It would run off of an Arduino Uno. The paper briefly mentions the plans for further research into the topic.

- Pipelines and Parks: Evaluating External Risks to Protected Areas from the Proposed Northern Gateway Oil Transport Project
- Service, Christina N., Nelson, Trislayn A., Paquet, Paul C., Mclnnes, Will S.S., and Darimont, Chris T.

https://bioone.org/journals/natural-areas-journal/volume-32/issue-4/043.032.0404/Pipelines-and-Parks--Evaluating-External-Risks-to-Protected-Areas/10.3375/043.032.0404.full

  - Discusses how parks cannot really make jurisdictions on actions that happen outside the park, even if it would increase the safety of the park.
    - Such as jurisdictions on oil pipelines that threaten parks if a spill happens
  - Discusses how risk management in planning is critical and the risk of oil pipeline spills are not 0 at all and that is why they should be more carefully examined
  - With a very large oil pipeline planned in Canada (at the time of this papers writing) there is significant risks to the 34 parks that are down stream of the pipe if it were to spill
  - Discusses creating a risk index model using GIS to determine the risk factor of each of the parks downstream
  - Discusses the relative unavailability of commercial software that can simulate the dispersion and flow of spilled oil
  - Discusses what would need to be changed from a water flow model to an oil flow model
    - Would need viscosity, temperature of air and liquid, shoreline vegetation characteristics, substrate material, shape of water body path, and quantity of spill material
  - Discusses how water ways are not the only thing that is in danger of mass contamination by an oil spill, many terrestrial areas would be highly affected

This paper is about the dangers of a land-based oil pipeline spill and the subsequent damages that would be sustained throughout waterways and terrestrial areas, specifically parks. The paper discusses how there is little commercial software available that can simulate the oil spill dispersion and flow modeling. There is considerable need in risk management when constructing pipelines that is not taken into account. Having the software to model oil spill trajectories is something that would only benefit the entire natural ecosystems and people who live off of the water provided by the waterways that would be contaminated. The paper does a risk analysis using water flow sampling to see that 34 parks and thousands of hectares of land would be devastated by an oil spill anywhere along the studied and projected Northern Gateway Pipeline going through British Columbia.

- Characterization, Occurrence and Natural Attenuation of Spilled Light Synthetic Crude Oil in a Boreal Freshwater Ecosystem
- Zeyu Yang, Keval Shah, Ben Fieldhouse, Fatemeh Mirnaghi, Bruce P. Hollebone, Patrick Lambert, Michael Goldthorp, Carl E. Brown, Chun Yang

  https://www.sciencedirect.com/science/article/abs/pii/S0016236120322729

  - Describes a major oil spill from a train derailing in Canada
    - The oil ran straight into a major river and samples all along the river were taken to see the effects of the oil
  - Gives details about the oil's viscosity and temperature data
  - Gives a chart and details about the different concentrations of Alkanes and Biomarkers at different testing areas
    - I have no idea about the compounds it is talking about, but it lists the concentrations of Alkanes of C09 to C40 and Biomarkers
  - Discusses the various fractions of TPH, TSH, and TAH
    - Again, I don't know what these are
  - Heavier oil particles were found farther downstream than a lot of smaller particles that were lost due to weathering processes such as evaporation, biodegradation, and photo-oxidation
  - Goes into detail about why heavier oil particles were weathered less than the lighter ones
    - Deals with the amount of microbial degradation being greater on lighter particles than the heavier ones – deals with the makeup of the alkanes and biomarkers in the particle (what makes it a light or heavy particle)

  This paper is about the study of a major oil spill in Canada that flowed straight into a river. There were many different testing sites that were used throughout many months after the oil spill. The paper goes into great detail about the different microbial and chemical make-up of each of the different categories of particles (light and heavy). There is a great focus on the biodegradation of the particles and the loss of particles down the river over time and why there is a discrepancy between the number of heavy particles and light particles. The discrepancy was caused by mostly the biodegradation of light particles over heavy particles because of their chemical and microbial make-up.

- Establishment and application of oil spill model in inland waterway
- Pinfeng Jiang, Sichen Tong, and Yiting Wang

  https://iopscience.iop.org/article/10.1088/1755-1315/643/1/012126/pdf

  - Discusses the methods for creating the model of oil spills over land and mostly into riverways
    - Uses different viscosity measures for oil film thickness to judge size and shape
    - Gives a formula for calculating the average thickness of oil
    - Also gives a formula for calculating the size of the oil film based on the average thickness
    - Also gives a formula for calculating the diffusion of the oil
    - Also give a drift formula for the oil slick
    - Also gives a formula for drift distance of oil slick
  - Describes tests on the model and the results being that the model was mostly accurate (92% accurate)
  - Mentions that this is a good start and needs to be implemented with a GIS for further study and better visualization

  This paper is about oil spills that occur inland and spill into river ways. The paper gives many good formulas for the different ways that oil moves and navigates the terrain and specifically riverways. There is a lot looking up in this paper to say that models are feasible and with the help of a GIS that they could be practical. The paper does not focus much on the over the land part of the oil spill and focuses almost entirely on the water ways aspect.

- Modeling of oil spill spreading disasters using combination of Langrangian discrete particle algorithm with Cellular Automata approach
- Maciej Glug, Jeroslaw Was

  https://www.sciencedirect.com/science/article/abs/pii/S0029801818300295

  - This is about water-based oil spill modeling
  - Discusses the various data inputs needed for a spill model
    - Such as viscosity, amount, spill rate, location, different temperature, wind, and barometric pressures along with salinity levels in the water.
  - Mentions that this model could be augmented to be used for land based with a lot more math and modeling
  - Discusses and give a diagram of the process of the model algorithm
  - Goes deeply into the math behind the diffusion and other processes in the algorithm
  - Describes the differences between different models and a real oil spill

  This paper is about a model that was created using a lot of different math techniques to simulate the flows of oil during an offshore spill. There is a lot of math and it really describes the way that data inputs in the model for the oil qualities and environmental factors affect the output. It gives comparisons to different models that are already available before this new model the paper is about and also compares the models to an actual oil spill that happened. It mentions that the techniques and math that goes into creating the model in the paper can be used to create a land-based oil spill model if there is more math going into the model for the land that the oil is spilling on.

- Flammable Liquid Fire Consequence Modeling
- Jesus Aguilar Serrano, Mohd Rapik Saat, Ph.D.

  https://iopscience.iop.org/article/10.1088/1755-1315/643/1/012126/pdf

  - Discusses oil spill event that triggered the need to write the paper
  - Goes into detail about the need for an oil spill model such as the one I am proposing
    - Using GIS and DEM
    - Discusses why off-shore models do not work for surface models
  - Goes into the methodology of the model
    - Uses lowest point relative to pixel cell (a specific location on the ground in the GIS) to determine flow pattern
  - Discusses the need for further research and why this is a critical piece of risk management
  - Also discusses how the model could be improved and furthered to include risk management for fires due to oil being so flammable
  - States the accuracy of the model is realistic

  This paper is about need and development of a crude oil spill modeling system for land-based spills. The model was developed using ArcGIS and a digital elevation map (DEM) to model the spill pattern that would be expected to be seen in an actual disaster. The model was put to the test against an actual spill that happened and the paper states that the model was accurate enough to be deployed for first responders to help mitigate damages and warn citizens. The paper concludes by stating the need for this model to be further developed and the directions that this could be taken – for fire prevention and higher accuracy in modeling.

- Geoclaw-Landspill: An Oil Land-Spill and Overland Flow Simulator for Pipeline Rupture Events
- Pi-Yueh Chuang, Tracy Thorleifson, and Lorena A. Barba

  https://joss.theoj.org/papers/10.21105/joss.03114.pdf

  - Is a software developed to simulate oil and other hazardous liquid flow and dispersion during a land-spill event.
  - Has the features of:
    - Point sources with multi-stage inflow rates to mimic rupture points along a pipeline
    - Lewis Squires Correlation for temperature-dependent flow viscosity
    - Darcy-Weisbach friction model with multi-regime coefficient models (laminar, transient, and turbulent regimes)
    - Inland waterbody interactions
    - Fingas' evaporation models
    - Optimizations to improve performance in overland flow simulations
    - Automatically download high-resolution topography and hydrology data
    - Create CF-compliant NetCDF raster files for mainstream GIS software (e.g., QGIS, ArcGIS)
  - Has a statement of need describing how there has been an average of 388 hazardous liquid pipeline spills per year in the US between 2010 and 2017 and Geoclaw is the only high-fidelity spill modeling software commercially available

  This paper is about the land-spill model designed for risk management for hazardous pipeline spills. There have been hundreds of hazardous pipeline spills in the US every year and there is only one hazardous spill-modeling system commercially available and that is Geoclaw. The software has many features to accurately model and simulate a spill in real-time in any location that has been mapped by a GIS and imported into the software. Location data is needed for any model to be created by Geoclaw. It is actively being developed by a small dedicated team and is being used to simulate spills to help mitigate damages and plan accordingly for such events.

- GIS Technology Applied to Modeling Oil Spills on Land
- Will Farrar, Chris Galagan, Tatsu Isaji, Kelly Knee

  https://proceedings.esri.com/library/userconf/proc05/papers/pap2129.pdf

  - Discusses the GIS land model for the oil spill simulation from a pipeline
  - Gives the criteria for the model to function
    - Things such as boiling point of the oil, the location, spill rate and amount, elevation, land cover data, surface water networks, and other environmental inputs
  - Talks about the methodology of creating the model by how the oil would move towards water areas most likely due to runoff paths that the water takes when it rains to get to the water areas
  - How it would pool in certain areas due to geography
  - Discusses the math behind the creation of the model and the flow predictions
  - Discusses the way oil would behave if it ran into a large water area such as a lake or pond – it would spread out until it got to a minimum thickness and then get thicker

  This paper is about the models created using GISs and data from different areas of oil research. There is not a lot of data already present in order to get a good understanding of how accurate these models are, it says in the conclusion that more data is needed from experiments or actual spills to get a better understanding of how accurate the model is. The math that goes into the creation of a model is discussed and also the damages that would actually happen to the environment when there is a spill or if there is another one.