WSM 2021

Study of Urban Community Emergency Management in Huizhou, China

Paper ID: W011

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Abstract

This paper focuses on the study of urban community emergency management in Huizhou, China. An index system for urban community emergency management evaluation which has two levels is established in the study. The index system consists of six primary indicators and twenty-two secondary indicators. The weights of the indicators are determined by using the Analytic Hierarchy Process (AHP). The established evaluation system is used to evaluate the emergency management ability of a community called Xuefu Community in Huizhou, China. Purpose sampling is used in the evaluation. A questionnaire with twenty-three questions is designed and all community staff are invited to answer the questionnaire. Fuzzy Comprehensive Evaluation method is adopted to calculate the scores and resulted are analysed. Suggestions are given to the Xuefu Community and local government based on the analysis.

Introduction

In China, the community emergency management system relies heavily on the local government and the research on emergency management mode at community level mostly focuses on theoretical discussion and policy elaboration while the empirical research based on investigation is lacking [1]. Huizhou is not a top-level city in China and the emergency management is relative backward. The community emergency management in Huizhou does not refer to the actual situation and the community emergency system is mostly copied from the city emergency system. No enough attention has been paid to the community emergency management. The potential losses in Huizhou communities are high when typhoon and floods occur.

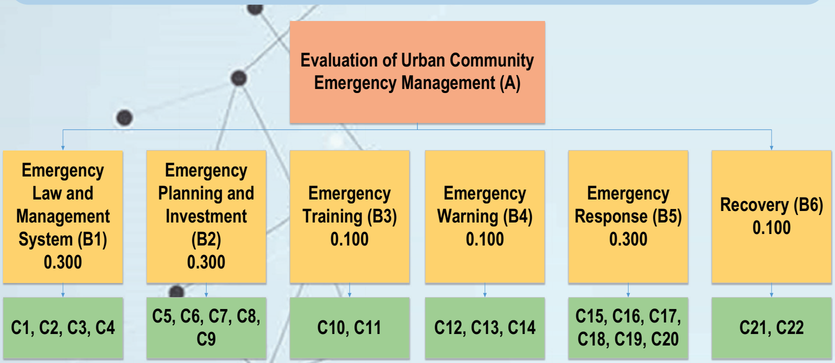
Establishment of Evaluation System

In this study, the 4R theory of crisis management [2] is used to build the framework of the evaluation index system and indicators from the existing emergency management system in China [5], [6] and disaster management system in Japan are used as references [4]. Research articles that study Chinese community emergency management are also used as references to check the evaluation index system [1], [3], [7]. Seven experts from government and universities are invited to revise the index system and experts' opinions are adopted for revision.

This paper uses the Analytic Hierarchy Process (AHP) [8] to determine the index weights of the community emergency management evaluation system. Two experts who have rich experience in emergency management were invited to answer the questionnaire and the results were used to build the comparison matrices.

Evaluation Index System of Urban Community Emergency Management

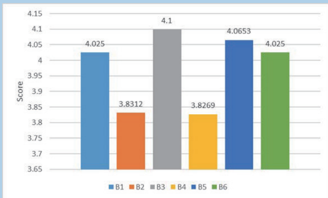
The final hierarchy of the system is designed to have two levels. The first level is designed to have six indexes while the second level has twenty-two indexes in total.



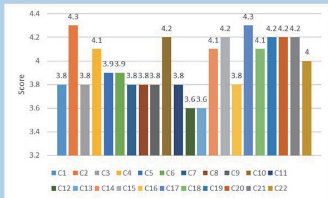
Evaluation of Xuefu Community in Huizhou

The new index system established in this study is used to evaluate the emergency management capability of Xuefu Community. Fuzzy Comprehensive Evaluation is adopted to calculate the exact scores of all different indicators. To ensure the validity and authenticity of the evaluation result, this study uses purpose sampling. All community staff are invited to answer a well-designed questionnaire that can be used to calculate the final score. The final overall emergency management capability score for the Xuefu Community is 3.9669/5 which is a bit lower than the good level.

Results



Scores of primary indicators



Scores of secondary indicators

Conclusion

The overall evaluation score of Xuefu Community is 3.9669 which is slightly lower than the good level. It can be said that Xuefu Community's performance in emergency management is generally good but there are still a lot to improve. According to the analysis, the emergency planning and investment and emergency warning are the weaknesses of emergency management in Xuefu Community because the scores of them are lower than 4. In order to improve the emergency management ability effectively, Xuefu Community can focus on the aspects with low scores.

After obtaining the analysis results, this study also proposes some suggestions from the perspective of Xuefu Community and Huizhou government to help Xuefu Community to improve its management level. The community has to take actions to overcome its shortcomings mentioned in the analysis section and learn from other outstanding communities while the Huizhou government should give more support and encouragement.

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Disaster Response and EV use in Management of Mobility and Autonomous Energy Grid

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❖ Developing Optimal energy management strategy for autonomous energy grid with EV and waste energy recovery

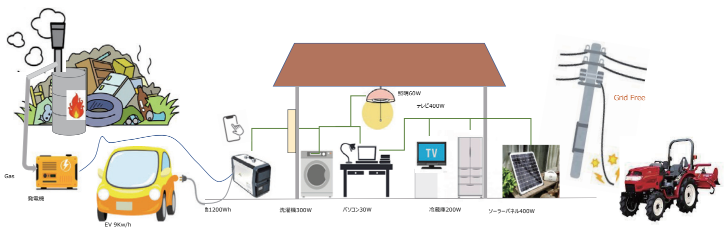
- Energy management optimization in a sparsely populated autonomous energy grid
- Consider the uncertainty of the arrival and departure time and energy consumption of electric vehicles
- Minimize the cost of non-renewable energy
- Minimize the number of scenario-based expected constraint violations

❖ Providing efficient routing method for delivering energy to shelters in disaster response operation

- Replenishing electricity due to distribution planning issues to achieve decentralized evacuation
- Minimize energy loss due to movement
- The supply time constraints and energy capacity constraints for the supply of vehicles at each demand base point
- There are a total of 7 power demand bases in the actual disaster area, and we can solve optimization problems at a high speed

Challenging issues:

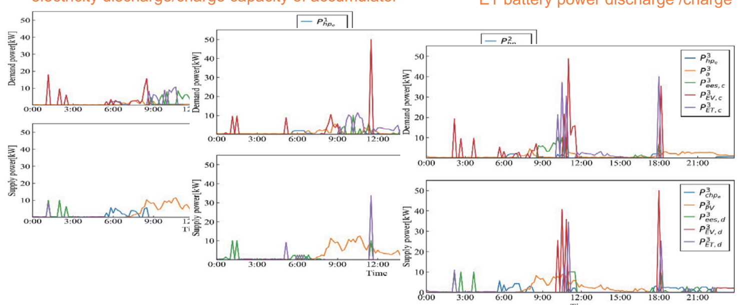
- Automatic control of furnace for sisaster waste energy regeneration (for robust combustion treatment operations)
- Energy management of autonomous grid with consideration of mobility demand of electric vehicle
- Efficient routing for delivering energy with shelter prority



Solution by solving optimization problem:

$$\min \sum_{k=0}^{H-1}\Bigg(c_{gas}P_{gas}(k) + \sum_{l=0}^{N_h}\Bigg(c_{ees}\left(P^{h_l}_{ees,d}(k)-P^{h_l}_{ees,c}(k)\right) + c_{EV}\sum_{n=1}^{N^{h_l}_{EV}}\left(P^{h_l}_{EV,d_n}(k)-P^{h_l}_{EV,c_n}(k)\right) + c_{ET}\sum_{n=1}^{N^{h_l}_{ET}}\left(P^{h_l}_{ET,d_n}(k)-P^{h_l}_{ET,c_n}(k)\right)\Bigg)\Bigg)\Delta t$$

gas — EV battery discharge/charge — electricity discharge/charge capacity of accumulator — ET battery power discharge /charge



On-going project:

- Constructing automatic control system
- Developing energy trasformation system: Thermal energy → Electricity →Power storage

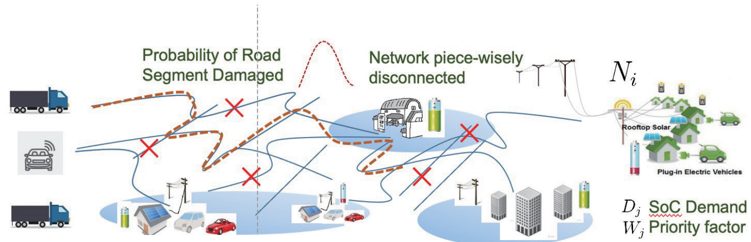
Energy Research Team

Professor Tielong Shen
Associate Professor Edyta Dzeiminska
Assistant Professor Wenjing Cao
Post-doctoral Fellow Zhenhui Xu
Post-doctoral Fellow Kai Zhao
Professor Masafumi Miyatake
Associate Professor Orie Sakamoto

Delivering energy to shelters

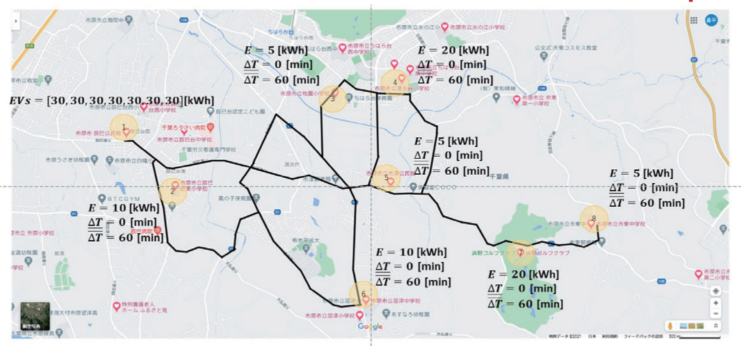
Destination priority ?
Urgency ?
Uncertainty ?

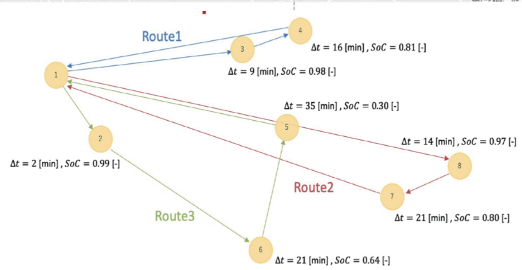
Under constraints, determine the route that minimizes the cost



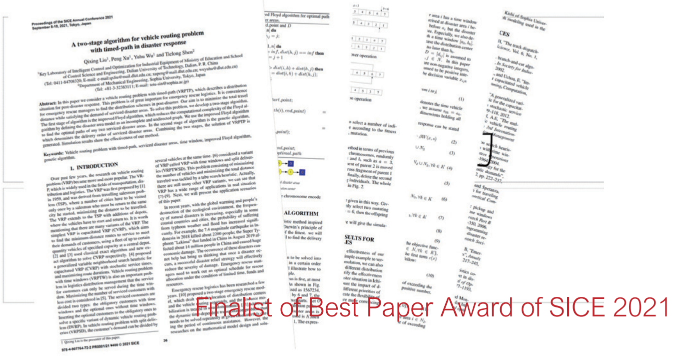
Joint Research with TOYOTA

Benchmark Example





A two-stage algorithm for vehicle routing problem with timed-path in disaster response



Finalist of Best Paper Award of SICE 2021

A Comparative Study on Nitrate Contents in Vegetables between Northern Part of China and the Watershed of Lake Tega in Japan

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Introduction

- Nitrate is one of the most common chemical compounds in nature, and it is widely found in soil, water, and food. Three of human's main nitrate intake sources are vegetables, water, and cured meat [1] [2] [3]. Among them, vegetables are considered to be the most important dietary nitrate source [4]. High levels of nitrate contents in vegetables have been a significant health issue all over the world.
- It is generally considered that the increasing dietary nitrate intake by human is also positively correlated with an increased risk of cancer, methemoglobinaemia, hyperparathyroid, children polyuria, hypertension, carcinogenic nitrosamines, and so on [4] [5]. Infants under 3 months are particularly susceptible to infantile methemoglobinaemia due to their normal intestinal flora contributing to the generation of methemoglobin. Reduced oxygenation of the tissues can generate significant adverse implications for infants, and result in coma and death under the most severe circumstances.
- This research investigates the nitrate concentration in crops in two different Asian locations: the Northern Part of China and the Watershed of Lake Tega, Japan. The objective is twofold: 1) to gain more insights on nitrate contamination in vegetables in Asia; 2) to examine nitrate distribution in crops by measuring nitrate contents in various parts of crops.

Methods

- Our testing methodology first extracts a small amount of plant juice (in a range of 0.3 ml to 2 ml) from crop samples by squeezing them into a container; and then measures its nitrate ion concentration using a Horiba compact nitrate ion meter (LAQUAtwin-B741). This meter is based on the Ion Selective Electrode method. It is one of the most frequently used potentiometric sensors for determining various ions concentrations dissolved in aqueous solutions in both laboratory analysis and industrial and environmental monitoring.

Results and discussions

- With regard to the experimental results of nitrate contents in the four types of vegetables, higher levels of nitrate concentration was found in leafy vegetables such as Chinese cabbage and lettuce, whereas lower levels occur in tubers or fruits such as beetroot and tomato. It indicates a decreasing sequence of nitrate concentration from leafy, brassica, root and tuber, to fruiting vegetables as depicted in Figure 1. A nitrate concentration of 9,000 mg/kg, 8,100 mg/kg and 6,300 mg/kg were found in spinach, Chinese cabbage and lettuce, respectively. Moderate nitrate contents were found in root and tuber vegetables such as broccoli, turnip and beetroot with values of 3,400 mg/kg, 3,000 mg/kg and 1,400 mg/kg, respectively. Nevertheless, lowest nitrate concentration was found in one of the fruiting vegetables - cucumber with a value of 73 mg/kg.

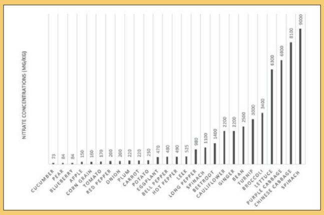

Figure 1. Nitrate contents in measured vegetables.

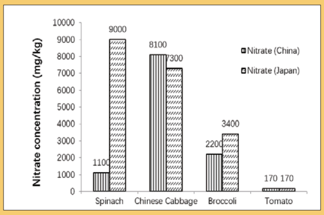

Figure 2. A comparison of nitrate contents between the northern part of China and the watershed of Lake Tega in Japan.

- From Figure 2, high nitrate concentration was found in Chinese cabbage from both the northern part of China and the Lake Tega in Japan with a value of 8,100 mg/kg and 7,300 mg/kg, respectively. Meanwhile, relatively low levels of nitrate were measured in tomato juice with a value of 170 mg/kg from both China and Japan. Furthermore, spinach and broccoli were found to have a higher nitrate level in Japan than that in China, particularly, highest nitrate concentration was found in spinach in Japan with a value of 9000 mg/kg.

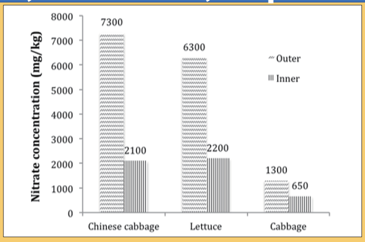

Figure 3. Distribution of Nitrate contents in three different vegetables.

Organs	Nitrate (Japan)	Nitrate (China)
Root 1(bottom)	8400	3000
Root 2(middle)	3400	2200
Root 3(middle)	1800	
Root 4(top)	1000	
Stem (closed to root 1)	9800	5300
Flower head 1(branch)	1700	860
Flower head 2(branch)	2200	
Flower head 3(central)	3400	

Table 1. Nitrate contents (mg/kg) in various parts of Broccoli

- We also measured the nitrate distributions between the inner and outer parts of the leaves for Chinese cabbage, lettuce, and cabbage. High nitrate content was found in the outer parts of those three vegetables with a value of 7,300 mg/kg, 6,300 mg/kg and 1300 mg/kg, respectively, whereas low nitrate levels was found among the inner parts with a value of 2,100 mg/kg, 2,200 mg/kg and 650 mg/kg, respectively. Thus, nitrate concentration in leafy vegetables illustrated a remarkably decreasing trend from outer (older) leaves to inner (young) leaves as depicted in Figure 3.
- Detailed nitrate contents of a brassica vegetable (broccoli) were tested within its stem, root and flower head, respectively from both North China and Japan as shows in Table 1. Nitrate concentration from the root of broccoli indicates a significant decreasing order from the bottom to the top, and the stem contains the highest nitrate concentration. However, nitrate contents in the flower heads, the edible part of broccolis, are found to be much lower than their roots and their stems. In addition, nitrate concentration in different parts of flower heads also shows an organized distribution that the nitrate concentration in the central part of the flower heads is much higher than the ambient part of the flower heads.

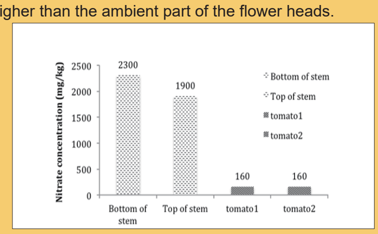

Figure 4. Nitrate contents (mg/kg) in tomatoes.

Samples	Inner stem	Outer stem	Inner tuber	Outer tuber
1	8600	Null	1000	2700
2	3100	230	310	910
3	4300	200	480	1700

Table 2. Nitrate contents (mg/kg) in turnip

- Nitrate levels in the fruit of tomato were measured with a value of 160 mg/kg, whereas it was as high as 2,300 mg/kg in the stem. In addition to that, nitrate concentration in the stem illustrated a slight decrease from the bottom to the top with values of 2,300 mg/kg and 1,900 mg/kg, respectively as shows in Figure 4.
- Nitrate contents in various parts of stems and tubers of turnip were measured, respectively. Nitrate concentration in the inner stem of turnip was found as high as 8600 mg/kg. Our results also illustrate the nitrate contents increase significantly from inner part to outer part inside of a tuber. On the contrary, the nitrate concentration decreases remarkably from inner stem to outer stem as shows in Table 2.

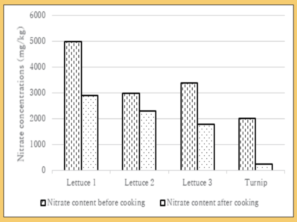

Figure 5. Nitrate content before and after boiling in lettuces and turnips.

- In this study, nitrate content in lettuce and turnip before and after boiling was compared and analyzed (as shown in Fig 6.). The nitrate concentrations of No.1 lettuce, No.2 lettuce and No.3 lettuce samples before treatment were 5000 mg/kg, 3000 mg/kg and 3400 mg/kg, respectively. Then, after boiling 1 minute, the corresponding nitrate concentrations of the three lettuce samples after cooking were 2900 mg/kg, 2300 mg/kg and 1800 mg/kg. The results showed that the nitrate content of three lettuce samples decreased by 42%, 23.33%, and 47.06%, respectively.

Conclusions

- The order of nitrate accumulation was spinach > cabbage > lettuce > broccoli > radish > cauliflower > beetroot > eggplant and fruit.
- For vegetables sampled in the Northern part of China, a nitrate level up to 8,100 mg/kg was found in Chinese cabbage. For vegetables sampled in Japan, a nitrate level up to 9, 000 mg/kg and 7,300 mg/kg were found in spinach and Chinese cabbage.
- Findings from the detailed testing of nitrate distributions in various parts of crops suggests that some portions of vegetables, such as the inner part of Cabbage and turnip, can be considered as much suitable and healthier for young children.
- The nitrate content of vegetables before and after cooking is very different. After cooking, the nitrate content of vegetables is very much reduced.

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Power Scheduling for Large-Scale EVs with Traffic Information and MFG Strategies

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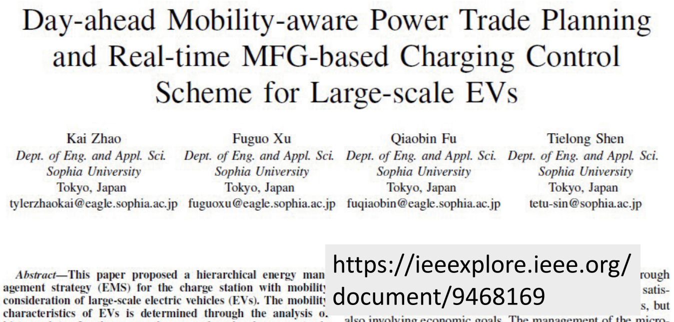
Introduction

The high increasing penetration of EVs into the power grid, on the other hand, is becoming a key issue due to the stochastic pattern of charging demands.

The optimization goal is to maximize the profit of the charging station via electricity trading with the grid and charging/discharging management of the EVs parking at the station featured as:

- Real-world-based traffic data of vehicle parking and commuting activities
- Two-layer system structure for electricity power scheduling and EV cluster power management
- Mean-field-game-based consensus charging management in each EV cluster



Day-ahead Mobility-aware Power Trade Planning and Real-time MFG-based Charging Control Scheme for Large-scale EVs

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https://ieeexplore.ieee.org/document/9468169

Optimization Goal

- Maximize charge station profit
- Scheduling the time and amount of electricity power traded among the grid, the station and the EV swarm

$$\max J = \sum_{k=1}^{T}\{-[(\rho+\Delta\rho)\,P^k_{g2s} - \Delta\rho\,\kappa(P^k_{g2s})P^k_{g2s}] + [(r+\Delta r)P^k_{s2v} - \Delta r\kappa(P^k_{s2v})P^k_{s2v}]\}$$

Grid to station — station to EV

Upper-Layer: Large-Scale Scheduling

- Scheduling the overall electricity power between the grid, the station and the whole EV swarm parking at the station
- Statistical data from the traffic big data, number of vehicles parking, departure, arrived, and SOC of the swarm at station, at each hour

Whole EV swarm SOC dynamics

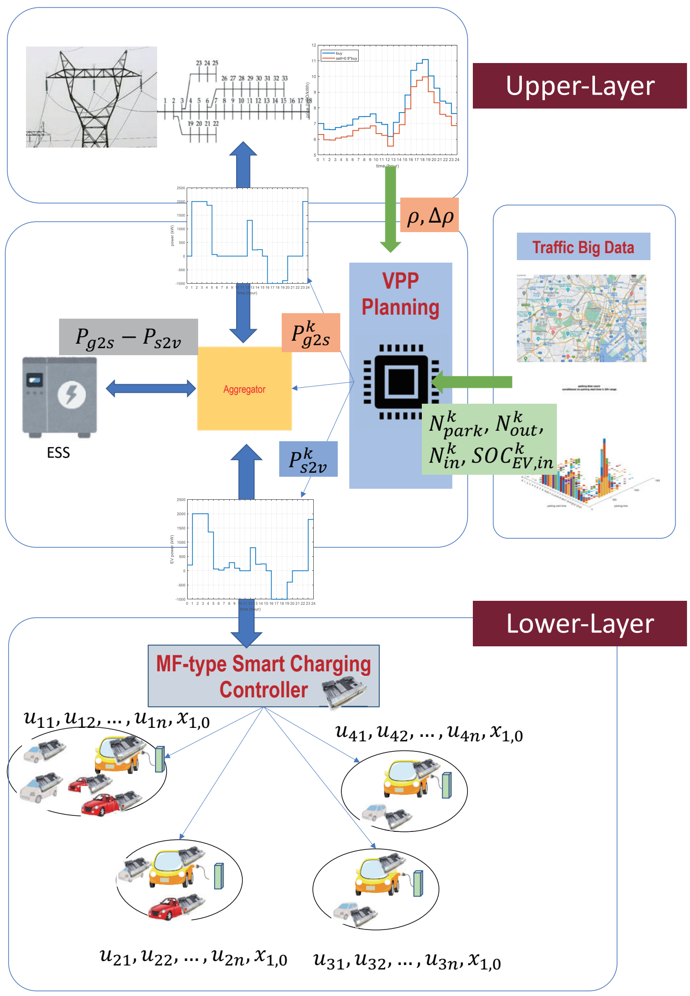
$$SOC^{k+1}_{EV} = \frac{SOC^k_{EV}(N^k_{park}-N^k_{out}) + SOC^k_{EV,in}N^k_{in}}{N^k_{park}-N^k_{out}+N^k_{in}} + \frac{P_{s2v}\Delta t}{Cap_{EV}(N^k_{park}-N^k_{out}+N^k_{in})}$$

Lower-Layer: Distributed and Consensual EV Power Management

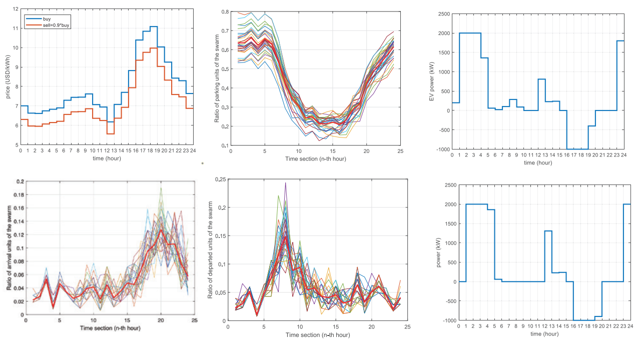
- Scheduled power usage P^k_{s2v} assigned to each EV cluster, based on the number of vehicles in the cluster
- Mean-field-game-based strategy for charging/discharging by each vehicle in a cluster

$$\min J(u_j, x_{j,0}) = \int_0^T\left\{\gamma_1\left(x_j(t)-\bar{x}(t)\right)^2 + \left(u_j(t)-\alpha_j P_{s2v}(t)\right)^2\right\}dt + \gamma_2\left(x_j(T)-x_T\right)^2$$

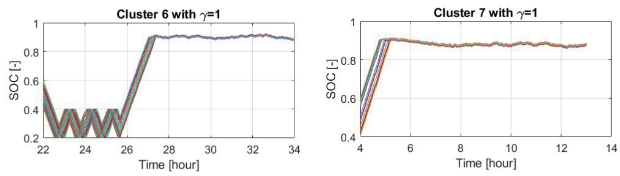
System Structure



A Numerical Study



JEPX electricity price, traffic data, EV charging/discharging schedule



MFG-based charging behavior

上智大学 理工学部
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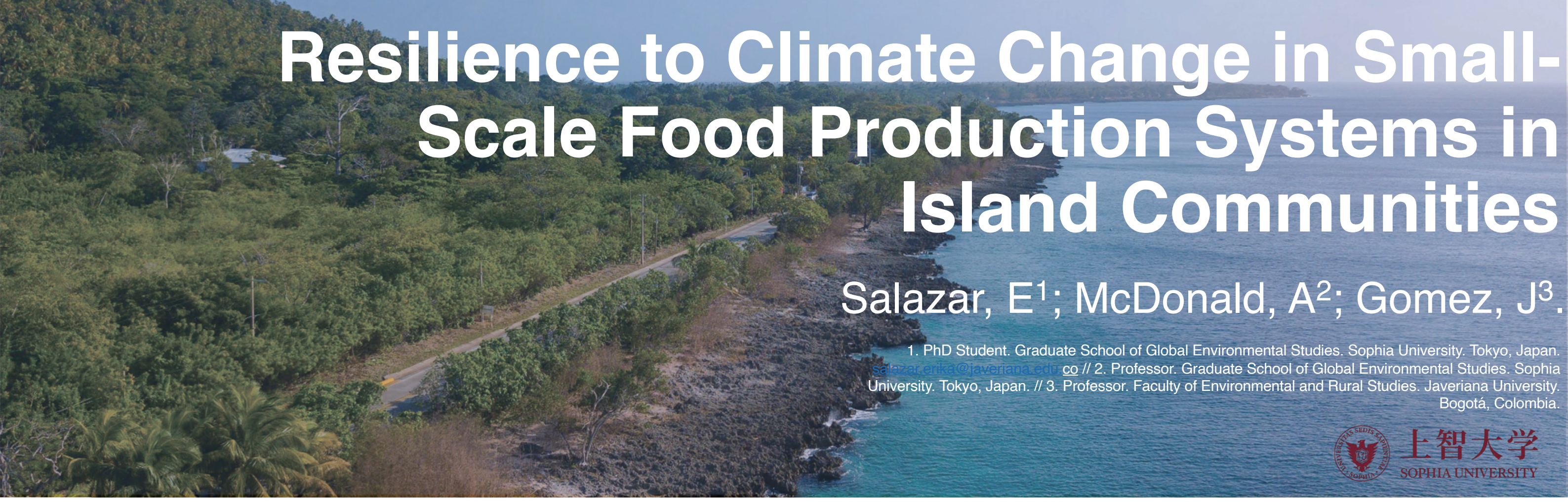

Resilience to Climate Change in Small-Scale Food Production Systems in Island Communities

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INTRODUCTION

Cropland, Laura Community (Republic of the Marshall Islands)
Photo by: Lajkit Rufus

- Approximately 2 billion people are involved and depend on small-scale agriculture and fisheries[1], producing one third of the food consumed by humans globally
- Small-scale food production is greatly based on traditional, indigenous, and local knowledge developed from empirical observation[2]
- Food insecurity is expected to increase with climate change due to upcoming impacts from extreme events such as floods, desertification, droughts[3,4]
- Agriculture, Forestry and Other Land Use (AFOLU) activities represents 23% of total GHGs. There is a need for sustainable solutions to increase resilience and maintain food security and sovereignty[4]
- Low- and middle-income countries located in tropical and subtropical areas are especially vulnerable[5]
- Islands are at the frontlines of climate change and need to be prioritized[6]

OBJECTIVE

The study aims to identify drivers that determinates resilience to climate change in food production systems such fisheries and agriculture in different islands from a comparative approach.

Fisherfolks in Providence (Colombia)
Photo by: Nick Howard

RATIONALE

In islands, vulnerability increases due to a set of characteristic such as:

- Small land area and limited natural resources such as soil, fresh water and energy[7]
- Remoteness from economic centers
- High exposure to environmental impacts such as cyclones, hurricanes, drought and flooding, among others[8, 9]
- Heavy reliance on imported food impacting local community's health (i.e., obesity and NCDs)[10, 11]

CASE STUDIES

Figure 1. Case studies location. Pacific Islands: Ponhpei in Federate States of Micronesia (FSM) and, Republic of Marshall Islands (RMI). Caribbean Islands: San Andrés and Providence, Colombia.

Women arranging mangrove seedlings (San Andrés, Colombia)
Photo by: Ruben Azcarate

METHODOLOGY

Mix approach (qualitative and quantitative) including surveys and in-depth interviews.

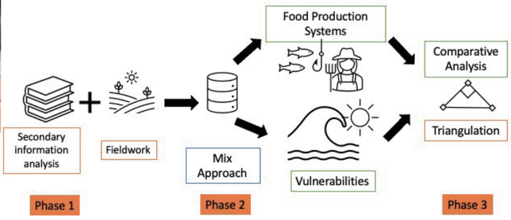
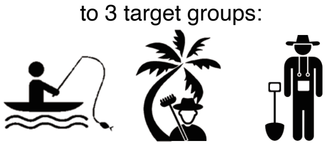
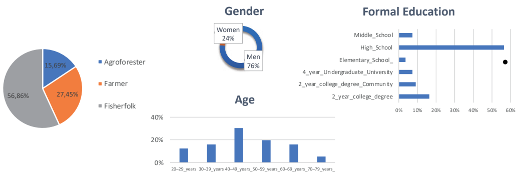


Figure 2. Diagram of the methodology implemented for this research.

Questionnaire has been addressed to 3 target groups:



RMI and FSM fieldwork is still in process
San Andres and Providence: 55 completed questionnaires



PRELIMINARY FINDINGS

- Transition to *cash cropping* (including monoculture and the use of chemical inputs) has represented a **strong shift** away from traditional low-input and diversified agroecological/agroforestry systems, having economical and ecological implications for small-scale farmers in island communities
- *Soil erosion and overfishing* are the main **challenges** for food production identified by small-scale farmers and fisherfolks (nearshore) in islands communities
- Adjusting sites (planting/harvesting *grounds, changing land/sea use*) and times (*seasons/schedules, modifying months and hours to fish*) for farming/fishing (nearshore) is the main **strategy to adapt** to the impacts of climate change such as extreme weather events identified by the respondents
- *Recovering ecosystems* and the *revitalization of traditional/local knowledge* (home gardening, agroforestry, traditional plant associations, mulching and natural fertilization) were perceived by the respondents as the main **factors to decrease vulnerabilities and increase resilience** to the impacts of climate change, which are starting to be implemented mainly from government initiatives
- *Blue foods* (fisheries) are an opportunity to develop more **resilient livelihoods** if undertaken sustainably, being a pillar for food and nutrition security, economic development and cultural preservation in island communities due to their rich maritime history and resources
- Need for expansion of **ecologically sensitive production** such as implementation nature-based solutions (nutrient and pest management in farming / fishing techniques) and integrating ridge to reef approach acknowledging the links between resource management, conservation and sustainable use in different ecosystems from *socio-ecological system framework* (i.e. reforestation in land management for farming helps to reduce soil runoff which impacts marine ecosystems)

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Real-time Energy Management Strategy for HEVs in Connected Environment

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❖ OVERVIEW

1. Introduction

❖ Motivation

➢Environmental issue

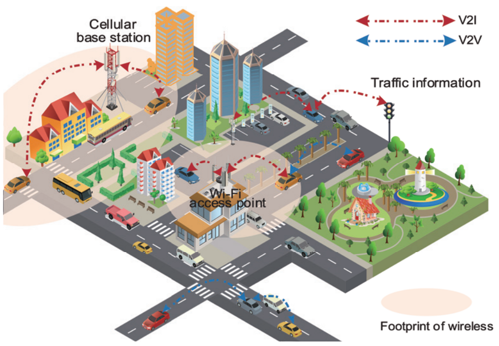
Global temperature increase; Air pollution; Traffic jam; Traffic accident…

➢Why Hybrid Electric Vehicles (HEVs) ?

- To improve fuel economy and reduce emission
- Characteristic of HEVs: recharging & high fuel efficiency

➢Challenge for HEVs

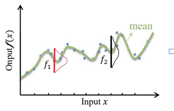
- Distributing energy between engine & motor (EMS)
- How to actively use traffic information for improvement of fuel economy in connective environment



2. Prediction with Traffic Information Using

❖ Gaussian process (GP)

a GP is distributions over functions



drawn with

mean function μ

kernel functions k

$$\sigma_f^2 exp\left\{-\sum_{i=1}^{d}\frac{(x-x')^2}{2\sigma_l^2}\right\}$$

The predictive conditional distribution conditioned on the training values $p(\boldsymbol{f}^*|\boldsymbol{y},\sigma^2)$, is given as (Gaussian Conditionals)

$$p(\boldsymbol{f}^*|\boldsymbol{y},\sigma^2) \sim N(\mu^*,\Sigma^*)$$

$$\mu^* = K^{*T}(K+\sigma^2 I_n)^{-1}y \quad \Sigma^* = K^{**} - K^{*T}(K+\sigma^2 I_n)^{-1}K^*$$

➢How to use GP?

hyperparameters optimization $\theta = \langle\sigma_f,\sigma_l,\sigma^2\rangle$

maximum likelihood.

$$\theta_{max} = \arg\max_{\theta}\{\log(p(\boldsymbol{y}|\boldsymbol{x},\theta,\sigma^2))\}$$

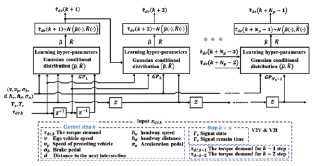
make the density as high as possible at $y_i = C$

➢Why use GP?

- Deal with uncertain relationships between inputs and outputs.
- GP predicts a normal distribution of the output instead of a certain output.

❖ Torque demand prediction

➢Prediction structure



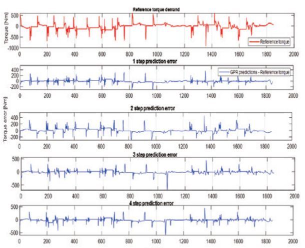
Structure of preceding vehicle demand prediction

- $\hat{\tau}_{dr,k}, (k = 1,2,\cdots N_p - 1)$ at each step k from the current time t, follows the GP as

$$p(\hat{\tau}_{dr,k}|x_{dr,k}) \sim GP\left(\hat{\mu}(\cdot),\hat{K}(\cdot)\right)$$

- The regression model GP_k is independent at each sampling step k; the historical traffic data are used to learn the kernel.

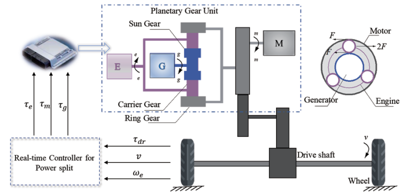
➢Prediction results



Torque demand prediction results with 4 step prediction horizons.

3. Energy Management System

❖ Powertrain model

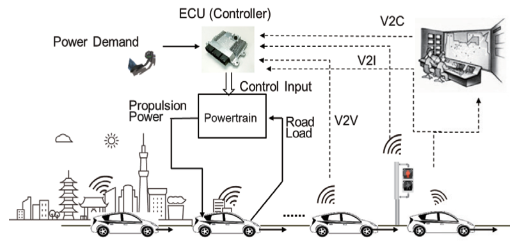


$$\begin{cases} M\dot{v} = \left[a_1\tau_e + a_2\tau_m + a_3\tau_g - a_4\tau_{brake} - a_5\tilde{F}(v)\right] \\ M\dot{\omega}_e = \left[b_1\tau_e + b_2\tau_m + b_3\tau_g - b_4\tau_{brake} - b_5\tilde{F}(v)\right] \end{cases}$$

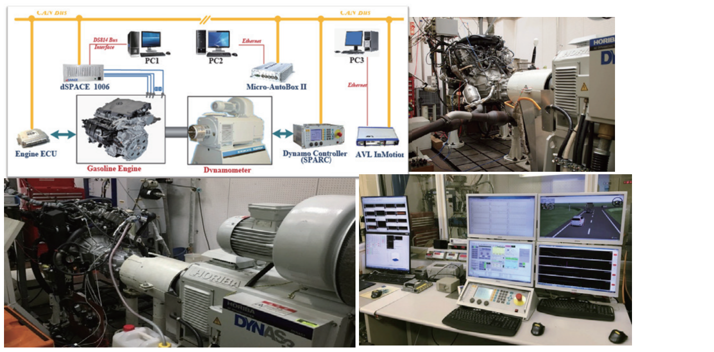
$$\begin{cases} \omega_m = \frac{R_r'}{R_r'}\cdot\frac{R_w}{R_r'+r'}\cdot\frac{1}{R_{tire}}v \\ \omega_g = \frac{R_r+R_s}{R_s}\omega_e - \frac{R_r}{R_s}\cdot\frac{R_w}{R_r'+r'}\cdot\frac{1}{R_{tire}}v \end{cases}$$

$$\tau_{dr} = R_{tire}\left(a_1\tau_e + a_2\tau_m + a_3\tau_g - a_4\tau_{brake}\right)$$

❖ Optimal control scheme



❖ Engine experimental platform



❖ Traffic-in-the-loop (TILP) co-simulation platform