Fieldnet Lounge Symposium

Visualizing Diverse Socio-Environmental Systems: Toward Robustness Beyond Resilience

Sunday, December 3rd, 2023

13:30 – 18:00 in Japan (UTC+09:00) / 7:30 – 12:00 in Jordan & Iraq (UTC+03:00)

Room 304: Multimedia Meeting Room
ILCAA, Tokyo University of Foreign Studies & Online (Hybrid)

Preface

This symposium aims to exchange different methodologies in fieldwork among young researchers of the human and natural sciences, emphasizing the "Fertile Crescent" in the Middle East. The interdisciplinary interaction of researchers will promote finding clues to derive feasible solutions based on a scientific understanding of social and environmental phenomena.

The historical Fertile Crescent has been the cradle of civilization, nourishing different cultures and sciences. The current societies and environments of the Fertile Crescent face extremely high vulnerabilities due to the mutual influence of political turmoil, uneven distribution of natural resources, cross-cultural conflicts, and climate change, controverting resilience in the context of the United Nations's sustainable development goals (SDGs). This symposium shares the knowledge and methods in both human and natural sciences to tackle these issues of social and environmental vulnerabilities by posing the notion of robustness that overcomes the limitations of resilience.

Resilience implies the property of reverting toward goals or the asymptotic stability toward an equilibrium point in mathematical terms. This requirement is too strong considering the reality of the Fertile Crescent, home to various ethnic and sectarian groups, even averting a common goal. In contrast, robustness tolerates unstable equilibrium points and regime shifts in society and the environment and associates risk aversion by skillfully controlling perturbations.

Visualization is crucial in field studies to link fieldwork with theoretical approaches. The symposium participants investigate different methodologies, including statistical analysis, chemical analysis, and mathematical modeling, to visualize the diverse socio-environmental systems in the Fertile Crescent. The first of two sessions will discuss the visualization of "flows" in different social and environmental sciences contexts, and the second will discuss visualizing the notion of robustness.

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Opening

13:30 – 13:35 / 7:30 – 7:35 Greetings from Fieldnet

13:35 – 13:40 / 7:35 – 7:40 Opening Remarks

Organizer, Marie Sato (Institute of Humanities and Social Sciences, University of Tsukuba)

Session I: Visualization of Flows in Society and Environment 13:40 – 14:55 / 7:40 – 8:55

Chair: Doha Zeadeh (Faculty of Agriculture, Jordan University of Science and Technology, Jordan)

Co-chair: Tomoki Izumi (Graduate School of Agriculture, Ehime University, Japan)

13:40 – 14:00 / 7:40 – 8:00 Presentation 1

Speaker: Weimin Guo (Graduate School of Agriculture, Kyoto University, Japan)

Title: Stable isotopes to visualize the fate of nitrogen

14:00 – 14:20 / 8:00 – 8:20 Presentation 2

Speaker: Tomoki Nakamura (Institute of Humanities and Social Sciences, University of Tsukuba, Japan)

Title: Visualizing the Israeli-Palestinian conflict: Its influence on the behavior of Palestinian farmers

14:20 – 14:40 / 8:20 – 8:40 Presentation 3

Speaker: Shuntaro Togo (Faculty of Agriculture, Kyoto University, Japan)

Title: Porous media equations to visualize subsurface water flows

14:40 – 14:55 / 8:40 – 8:55 Q & A

14:55 – 15:10 / 8:55 – 9:10 Break

Session II: Visualization of Robustness in Socio-Environmental Systems 15:10 – 16:25 / 9:10 – 10:25

Chair: Mahnaz Lashkri (Strategic Projects & Partnership Manager, University of Kurdistan Hewlêr, Iraq)

Co-chair: Koichi Unami (Graduate School of Agriculture, Kyoto University, Japan)

15:10 – 15:30 / 9:10 – 9:30 Presentation 4

Speakers: Marie Sato (Institute of Humanities and Social Sciences, University of Tsukuba, Japan)

Tomoki Izumi (Graduate School of Agriculture, Ehime University, Japan)

Title: Visualizing soil moisture content and historical transformation of livelihood: A case of Irbid, Jordan

15:30 – 15:50 / 9:30 – 9:50 Presentation 5

Speaker: Eileen Joan Magero (Graduate School of Agriculture, Kyoto University, Japan)

Title: Duffing oscillator to visualize biennial bearing

15:50 – 16:10 / 9:50 – 10:10 Presentation 6

Speaker: Snur Hamid (Freelance Business Consultant, Slemani, Kurdistan Region, Iraq)

Title: Untangling livelihood issues and entrepreneurship challenges in Kurdistan Region

16:10 – 16:25 / 10:10 – 10:25 Q & A

16:25 – 16:40 / 10:25 – 10:40 Break

General Comments and Discussions 16:40 – 17:50 / 10:40 – 11:50

16:40 – 16:55 / 10:40 – 10:55 Comment I

Hitoshi Shinjo (Graduate School of Global Environmental Studies, Kyoto University, Japan)

16:55 – 17:10 / 10:55 – 11:10 Comment II

Kenichi Kashiwagi (Institute of Humanities and Social Sciences, University of Tsukuba, Japan)

17:10 – 17:50 / 11:10 – 11:50 General Discussions

Closing

17:50 – 18:00 / 11:50 – 12:00 Closing Remarks

Koichi Unami (Graduate School of Agriculture, Kyoto University, Japan)

Stable isotopes to visualize the fate of nitrogen

Weimin Guo [(1)]

[(1)] *Graduate School of Agriculture, Kyoto University, Japan*

1. Introduction Symbiotic nitrogen fixation (SNF) in legumes is a fundamental process for maintaining soil fertility and the continued productivity of organic cropping systems. The transfer of nitrogen (N) between legume and non-legume species growing together has been the subject of intense study. In this study, the $\delta^{15}N$ abundance method, which is a common experimental approach to determine the proportion of legume nitrogen derived from atmospheric fixation [1], visualizes the fate of N through SNF in clover-mint mixtures in an organic cropping system.

2. Materials and Method Figure 1 shows the experimental setup for the organic cropping system in a greenhouse. There are two plots of identical layout: horizontal type and inclined type (10 °). Each plot is divided into five areas: a blank area, a clover area, a mint area, a mixture area, and another blank area. During the growing seasons, soil pore water was sampled for nitrate-nitrogen (NO_3-N) concentration measurement by photometer analysis once a week. Plants from each area were sampled randomly once a month. Then, they were analyzed for total-nitrogen (T-N) content and $^{15}N/^{14}N$ ratio by an Isotope Ratio Mass Spectrometry (IRMS). Stable isotope data are reported as the isotope ratio $\delta^{15}N$ (‰) of the sample relative to the atmospheric air standard

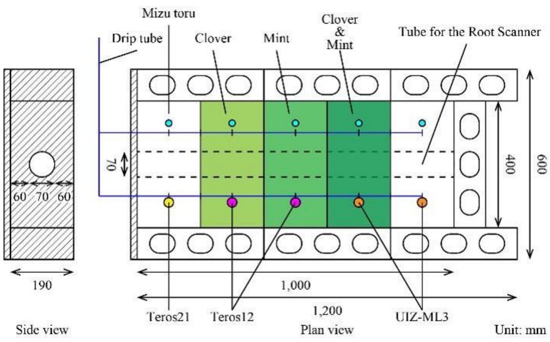

Figure 1. Schematic sketch of each plot in the field experiment (Prepared by Dr. T. Izumi, Ehime University)

$$\delta^{15}\mathrm{N}\ (‰) = \frac{R_{\mathrm{sample}} - R_{\mathrm{standard}}}{R_{\mathrm{standard}}} 1000 \qquad (1)$$

where R_{sample} and R_{standard} are the molar ratios $^{15}N/^{14}N$ in the sample and the standard, respectively. Percent N derived from the air ($\%Nfda$) for legume plant is calculated as

$$\%\mathrm{Ndfa} = \frac{\delta^{15}\mathrm{N}_{\mathrm{reference}} - \delta^{15}\mathrm{N}_{\mathrm{sample}}}{\delta^{15}\mathrm{N}_{\mathrm{reference}} - B} 100 \qquad (2)$$

where $\delta^{15}N_{\mathrm{reference}}$ is the $\delta^{15}N$ abundance of the non-legume plants that rely on soil mineral N, $\delta^{15}N_{\mathrm{sample}}$ is the $\delta^{15}N$ abundance of the clover samples, and B is a constant to represent the ^{15}N enrichment relative to atmospheric N gas of the legume grown solely with atmospheric N gas [2].

3. Results and Discussion The NO_3-N concentrations for each plot showed similar seasonal variations with the lowest values early and late in the growing seasons. However, the growth rate of the upper side in the incline type was delayed, while that of the lower side was faster and reached a higher peak. The T-N data shows similar time variations with the NO_3-N concentration. The overall changes in clover were more evident than that on mint in the horizontal plot, while it exhibited the opposite tendency in the inclined plot. The values of %Ndfa reached 34.5-69.7 (%) for the clover area in the horizontal plot, being the highest, followed by mixed clover and then mint areas. On the contrary, the values of %Ndfa were the highest for the mixed area in the inclined plot.

4. Conclusions This study demonstrated that N gas in the atmosphere could become a nutrient for clover's growth through SNF, though some would remain in the soil and be utilized by the adjacent mint. The visualized fate of N also highlighted the dependency of SNF on N-concentration in soil.

References

[1] Donahue JM, Bai H, Almtarfi H, Zakeri H, Fritschi FB (2020) The quantity of nitrogen derived from symbiotic N fixation but not the relative contribution of N fixation to total N uptake increased with breeding for greater soybean yields. *Field Crops Research*, 259, 107945.

[2] Jacot KA, Lüscher A, Nösberger J, Hartwig UA (2000) Symbiotic N2 fixation of various legume species along an altitudinal gradient in the Swiss Alps, *Soil Biology and Biochemistry*, 32(8), 1043-1052.

Visualizing the Israeli-Palestinian conflict: Its influence on the behavior of Palestinian farmers

Tomoki Nakamura [(1)], Kenichi Kashiwagi[(2)]

[(1)] *Graduate School of Life and Earth Sciences, University of Tsukuba, Japan*
[(2)] *Institute of Humanities and Social Sciences, University of Tsukuba, Japan*

1. Introduction After several wars since the First Middle East War broke out in 1948, the Oslo II Accord in 1995 agreed to provisional autonomy by the Palestinian Authority (PA) and agreed to transfer part of the security jurisdiction in the West Bank to the PA. Although it was agreed that the final status of the occupied territories would be left to future negotiations, the Israeli occupation of Palestine continues as of 2023. As part of the empirical economics studies, the West Bank was selected in this study as the area for empirical research to clarify phenomena regarding farmers' behavior in conflict-affected areas. During the Israeli occupation, the PA's agricultural policy has been to provide agricultural extension as support to farmers affected by the occupation. The purpose of this study was to quantitatively analyze and evaluate the effects of agricultural extension on technology adoption by Palestinian farmers.

2. Materials and Method It was hypothesized that agricultural extension would be effective in promoting technology adoption by Palestinian farmers in the areas affected by the West Bank Barrier and Israeli settlements. Microdata from the Palestinian Agricultural Census 2010 of the Palestinian Central Bureau of Statistics was used. For the estimation, the data was geographically divided by distance from the West Bank Barrier and/or Israeli settlements to evaluate the effect of agricultural extension in areas where the impact was significant. This study also compared the effects in areas near and far from the West Bank Barrier and/or Israeli settlements. The intervention of agricultural extension is not randomly assigned, and there may be a self-selection bias in farmers' willingness to receive or not receive agricultural extension. To mitigate this effect, Propensity Score Matching (PSM) was employed.

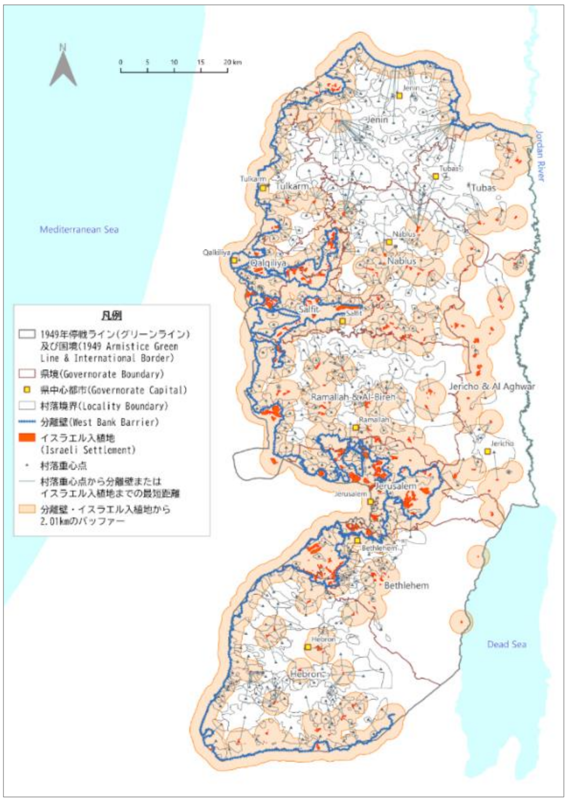

Figure 1. 2.01 km buffer from the West Bank Barrier and/or Israeli settlements (Prepared by the author based on geographic data from the OCHA Humanitarian Data Exchange)

3. Results and Discussion The estimates verified that even among farmers close to the West Bank Barriers and/or Israeli settlements (less than the median of 2.01 km), where the impact of the conflict is expected to be more pronounced, the treatment effects of agricultural extension have promoted the adoption of improved crop varieties, chemical fertilizers, organic fertilizers, pesticides, and agro-processing for marketing purposes. On the other hand, only for Integrated Pest Management (IPM), significant differences could not be verified. It is also possible that the West Bank Barrier and Israeli settlement may have negatively affected the implementation of agricultural extension as well, as the treatment effect was smaller than those farther from the West Bank Barrier (more than the median of 2.01 km), although statistically significant differences cannot be tested.

4. Conclusions The policy implication that can be drawn from the results of the empirical analysis in this study is that, as per the PA's policy goals, the effect of agricultural extension in areas where the effects of conflict and occupation are noted is likely to have promoted technology adoption by Palestinian farmers. However, in areas close to the West Bank Barriers and/or Israeli settlements, the effectiveness of agricultural extension may be reduced, and measures to increase its effectiveness are also needed.

Porous media equations to visualize subsurface water flows

Shuntaro Togo [1]

[1] *Faculty of Agriculture, Kyoto University, Japan*

1. Introduction A considerable part of the Fertile Crescent is not rich in surface water resources but depends on groundwater reserves [1]. Scientific understanding of water movement in aquifers is a prerequisite for establishing sustainable strategies for developing and managing groundwater resources, especially when conflicting stakeholders are involved. Conventional mathematical models of subsurface water flows include the Boussinesq groundwater equation and the Richards equation, which are nonlinear partial differential equations categorized as porous media equations (PMEs). This study overviews the astonishing properties of PMEs in their application to visualizing subsurface water flows.

2. Materials and Method The conservation law of water mass in a subsurface domain is written as

$$\frac{\partial \theta}{\partial t} + \nabla \cdot \mathbf{V} = S \qquad (1)$$

where θ is the volumetric water content, t is the time, ∇ is the three-dimensional (3-D) (x-y-z) del operator, $\mathbf{V}$ is the Darcy velocity, and S is the source term. Assuming the Darcy-Buckingham law, (1) is rewritten as the Richards equation

$$\frac{\partial \theta}{\partial t} = \nabla \cdot K(h)\left(\nabla h + \nabla z\right) + S \qquad (2)$$

where h is the matric potential, and K is the variably saturated hydraulic conductivity tensor depending on h. In an unconfined aquifer, integrating (2) in the saturated zone from the impermeable bottom z_b to the water table η (= $h + z$) results in the Boussinesq equation

$$\frac{\partial}{\partial t}\left(S_S \eta\right) = \nabla_{\mathrm{H}} \cdot \left(\eta - z_b\right) K_S \nabla_{\mathrm{H}} \eta + R \qquad (3)$$

where S_S is the specific storage, ∇_{H} is the horizontal two-dimensional (2-D) (x-y) del operator, K_S is the saturated hydraulic conductivity tensor, and R is the recharge rate. Under appropriate assumptions, such as in [2], each of the two model equations (1) and (2) is interpreted as the standard PME

$$\frac{\partial u}{\partial t} = \Delta u^m \qquad (4)$$

where u is the density as a generic unknown spatio-temporal function, Δ is the Laplace operator, and m is an exponent. For instance, normalizing (3) in a homogenous level aquifer without recharge yields (4) with $u = \eta$ and $m = 2$ in the 2-D space.

3. Results and Discussion One of the most notable features of PMEs is the degeneration of the "diffusion coefficient," implying finite propagation speeds of disturbances and loss of smoothness in the solutions [3]. In the 2-D space, the standard PME (4) with m = 1, the heat equation, has a C^∞ strong solution $u = \exp\left(-(x^2 + y^2)/4t\right)/t$, while the standard PME (4) with $m = 2$ has a Lipschitz continuous weak solution $u = \max\left(0, 1/\sqrt{t} - (x^2 + y^2)/16t\right)$ with bounded support for any t [4]. The theorem in [3] asserts more critical regularity results for $m > 1$, indicating the significance of visualizing subsurface water flow.

4. Conclusions It is inferred that the Richards equation and the Boussinesq groundwater equation have properties similar to those of the standard PME. Thus, the discussions based on PMEs' properties will contribute to the strategic development and management of groundwater resources in the real world.

References

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Visualizing soil moisture content and historical transformation of livelihood: A case of Irbid, Jordan

Marie Sato [1], Tomoki Izumi[2]

[1] *Institute of Humanities and Social Sciences, University of Tsukuba, Japan*
[2] *Graduate School of Agriculture, Ehime University, Japan*

1. Introduction The Hauran, a region spanning parts of southern Syria and northern Jordan, is renowned for its fertile volcanic soil rich in minerals, particularly basalt. Since the Bronze Age, the Hauran has played a significant role in agriculture, producing a variety of crops, with a current focus on olives. This paper's research site is Al-Shajara, a village near the city of Ramtha in Irbid, Jordan. The village's primary livelihood is agriculture, predominantly centered around olive cultivation. In Irbid, the olive tree-planted areas cover 25,022 hectares, constituting approximately 21% of Jordan's total olive tree cultivation area. Additionally, Irbid contributes around 32% of Jordan's overall fresh olive production [1]. Notably, a substantial livelihood transformation occurred in the 1980s when the dominant crops shifted from wheat, grains, and summer vegetables to olives. The transition was influenced by various factors, encompassing both environmental and socio-economic conditions.

2. Materials and Method Meteorological and soil moisture observations are conducted in an olive grove in this village. ATMOS-41 is used for meteorological observation, and 5TE (soil moisture sensor) and TEROS-21 (water potential sensor) are used for soil moisture observation. 5TE is installed at two depths of −0.10 m and −0.25 m, while TEROS-21 is installed at a depth of −0.25 m. Figure 1 illustrates observed precipitation and pF-value calculated from the water potential value throughout the year from September 2022. The paper draws on primary sources from fieldwork, incorporating qualitative interviews and observations conducted in the research site during September 2022 and March 2023.

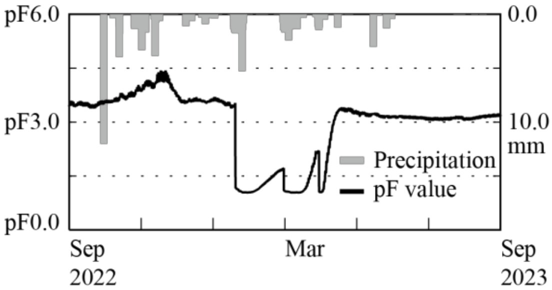

Figure 1. Observation of precipitation and soil moisture

3. Results and Discussion The research site in Al-Shajara, like many other farms in the region, practiced a triple cropping system until the 1980s. This system involved growing three different crops consecutively on the same land within a single year, namely wheat, grains such as lentils, fava beans, and chickpeas, as well as summer vegetables like watermelon. In the 1960s, wheat was the primary crop in Jordan. However, urbanization rapidly encroached on agricultural land, replacing wheat fields with concrete blocks. Despite an increasing population demand for wheat, its production dwindled. During the 1970s, American wheat began to dominate local markets, posing challenges for local farmers who struggled to compete with the higher costs of imported wheat. This trend was exacerbated by market liberalization policies and the removal of subsidies for local production. In the 1980s, Jordan faced an unprecedented economic and social crisis due to a significant decline in oil prices. Despite continued oil imports from Iraq at standard prices, Jordan found itself unable to meet foreign debt obligations. During this period, there was a noticeable shift among farmers as they transitioned their production focus to the more profitable cultivation of olives. From the observation of soil moisture, the period from January to May, when precipitation was observed, shows pF 1.0 to 2.0, while the rest of the year is above pF 3.0. Therefore, irrigation is necessary for crop cultivation during this period. Both wheat and beans, crops cultivated in the past, are now deemed challenging to grow without irrigation in today's climate conditions.

4. Conclusions In Jordan, it is believed that agricultural land has diminished due to rapid population growth and economic liberalization policies. This, coupled with the price competition with imported wheat, led to the transition of agricultural crops to olives in the 1980s. Furthermore, the results of field surveys indicate that under current soil moisture conditions, the calculated pF value exceeds 3.0, indicating that rainfed crop cultivation is considered challenging during the dry season.

References

[1] ILO (2014) Market Study and Marketing Strategy of Olive Sector in Irbid. Draft Report v2 (10 August 2014).

Duffing oscillator to visualize biennial bearing

Eileen Joan Magero [(1)]

[(1)] *Graduate School of Agriculture, Kyoto University, Japan*

1. Introduction Biennial or alternate bearing refers to the well-known phenomenon in fruit trees where the fruit bearing increases or decreases every other year. The biennial bearing of individual fruit trees is often synchronized and becomes evident in statistics of large-scale fruit production, such as at a country level. Biennial bearing tree crops having commercial or ecological significance in the Fertile Crescent include olive, apricot, pistachio, and oak. The celebrated resource budget model (RBM) is a deterministic time-discrete dynamical system explaining the mechanism of the biennial bearing, which is possibly synchronized due to coupling by anemophily [1]. This study aims to develop a time-continuous counterpart of the RBM, extending the Duffing oscillator that exhibits a wide range of anomalous phenomena due to its nonlinearity [2]. The boundedness of the conventional Duffing oscillator is reviewed before examining the properties of the extended Duffing oscillator via the numerical approach.

2. Materials and Method Time series data of annual olive yield from 1961 through 2020 in the Syrian Arab Republic are retrieved from the FAOSTAT website and utilized as a reference [3]. The time-continuous dynamical system considered here is the extended Duffing oscillator

$$\frac{\mathrm{d}\mathbf{u}}{\mathrm{d}t} = \frac{\mathrm{d}}{\mathrm{d}t}\begin{pmatrix} u \\ v \\ w \end{pmatrix} = \begin{pmatrix} -\rho u + \beta v \\ \alpha\rho u - w + \varepsilon \sin(\varpi t) \\ \omega^2 v - \mu w + \gamma v^3 \end{pmatrix} = \begin{pmatrix} -\rho & \beta & 0 \\ \alpha\rho & 0 & -1 \\ 0 & \omega^2 & -\mu \end{pmatrix}\begin{pmatrix} u \\ v \\ w \end{pmatrix} + \begin{pmatrix} 0 \\ \varepsilon\sin(\varpi t) \\ \gamma v^3 \end{pmatrix} = A\mathbf{u} + \mathbf{f}(\mathbf{u}) \qquad (1)$$

where t is the time, u is the pollen density in the atmospheric environment, v is an index of the resource involving the plant growth, w is an index of the plant biomass, and the Greek symbols represent the relevant non-negative parameters. The system (1) is the conventional unforced Duffing oscillator when $\mathbf{u} = (v, w)$, $\rho = 0$, and $\varepsilon = 0$. If the matrix A is diagonalizable as $P^{-1}AP = \Lambda$, where Λ is the diagonal matrix whose diagonal entries are the eigenvalues of A, then the energy function $H(\mathbf{x}) = \mathbf{x}\cdot\Lambda\mathbf{x}/2$ satisfies

$$\frac{\mathrm{d}H}{\mathrm{d}t} = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{1}{2}\mathbf{x}\cdot\Lambda\mathbf{x}\right) = \left\|\Lambda\mathbf{x}\right\|^2 + \Lambda\mathbf{x}\cdot P^{-1}\mathbf{f} = \left\|\Lambda P^{-1}\mathbf{u}\right\|^2 + P^{-1}A\mathbf{u}\cdot P^{-1}\mathbf{f} \qquad (2)$$

where $\mathbf{x} = P^{-1}\mathbf{u}$.

3. Results and Discussion The conventional unforced Duffing oscillator, whose $-A$ is positive definite, is bounded because of the evaluations

$$H - \frac{\gamma\mu}{4}v^4 = \frac{1}{2}\mathbf{x}\cdot\Lambda\mathbf{x} - \frac{\gamma\mu}{4}v^4 \le 0, \quad \frac{\mathrm{d}}{\mathrm{d}t}\left(H - \frac{\gamma\mu}{4}v^4\right) = \left\|\Lambda\mathbf{x}\right\|^2 + 2\gamma\omega^2 v^4 \ge 0, \qquad (3)$$

the second of which is deduced from (2). A boundedness result has not yet been obtained for the case of $\rho > 0$ with the external force. Therefore, the numerical approach is taken. Figure 1 shows the recurrence plots of the FAOSTAT data and the numerical solution of (1) with the parameter set $(\rho, \beta, \alpha, \omega, \mu, \gamma, \varpi, \varepsilon) = (1.0, 0.5, 0.5, \pi, 0.01, 5.0, 2\pi, 3.0)$ that constitutes $-A$ not being positive definite. The dynamics of biennial bearing with chaotic disturbances is visualized in both recurrence plots.

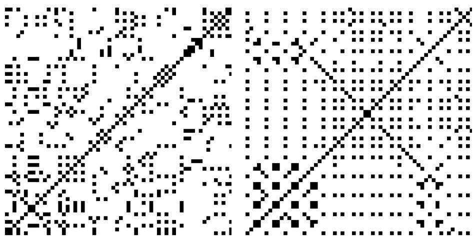

Figure 1. Recurrence plots of the FAOSTAT data (left panel) and the numerical solution of (1) (right panel)

4. Conclusions The extended Duffing oscillator can serve as a time-continuous counterpart of RBM. It will be further integrated as a spatially distributed model to include multiple individual fruit trees coupled with each other by anemophily.

References

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Untangling livelihood issues and entrepreneurship challenges in Kurdistan Region

Snur Hamid [1]

[1] *Freelance Business Consultant and Startup Coach in Silêmanî, Iraq*

1. Introduction This study seeks to delve into the current obstacles faced by startups, small businesses, and larger enterprises in the region. We aim to shed light on challenges spanning the economic, political, social, educational, environmental, and infrastructural spheres.

2. Key Focus Areas We focus on the areas below, which are the key to untangling livelihood issues and entrepreneurship challenges in the Kurdistan Region.

1. Banking system and financial access:
   - Exploring challenges related to opening accounts, depositing, withdrawing, and transferring money.
   - Addressing issues tied to access to finance and their impact on hindering business growth.
2. Political landscape and corruption:
   - Examining delayed salary payments to public sector employees.
   - Unpacking outstanding debts of oil and gas companies and the pervasive issue of corruption affecting livelihoods and entrepreneurship.
3. Infrastructure challenges:
   - Identifying obstacles caused by insufficient infrastructure, including unreliable electricity, transportation, and a deficient mailing system.
4. Environmental concerns:
   - Discussing the precarious water situation in the region and its potential impact on future water scarcity by 2035.
   - Highlighting how strategic planning for construction projects, specifically access to underground resources, requires thoughtful consideration.
5. Gender inequality:
   - Addressing the significant gender gap in the workforce, with 86.6% male representation and only 13.4% female.

3. Discussions We discuss the interconnectivity of the challenges and opportunities for change.

1. Interconnected challenges:
   - Demonstrating the interdependence of these challenges and their collective impact on the Kurdistan region’s economy.
   - Emphasizing the drawbacks of heavy reliance on oil, hindering efforts to diversify the economy, and impacting the success of business initiatives.
2. Opportunities for change:
   - Encouraging a proactive approach from both citizens and the government to address and overcome these challenges.
   - Highlighting the potential for a more resilient and diversified regional economy through comprehensive problem-solving.

4. Conclusions By unraveling these complex issues and fostering a deeper understanding, our presentation aims to inspire positive change and contribute to building a more robust and diversified Kurdistan economy.