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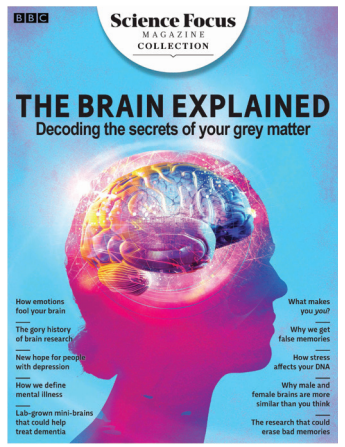
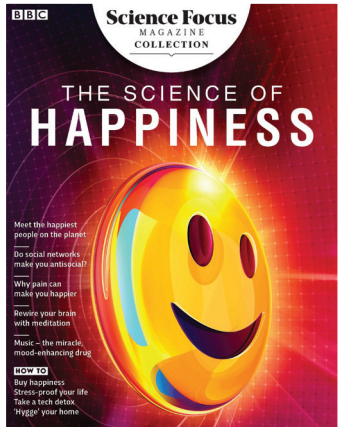
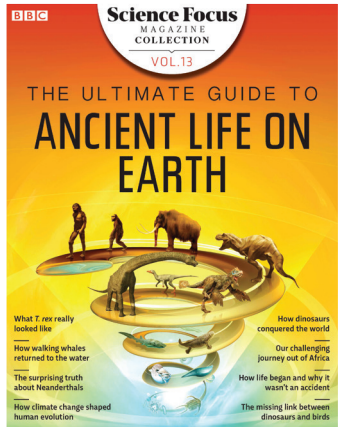
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KFAS Extends Beyond Education as a Catalyst for Positive Change

In the ever-evolving socioeconomic landscape, the Kuwait Foundation for the Advancement of Sciences (KFAS) has not only been introducing various educational initiatives but has also delved into critical research areas that could shape the country's future. The multifaceted approach of KFAS extends beyond education, encompassing vital aspects of environmental sustainability and urban development.

Addressing one of the pressing challenges in the region, KFAS has supported Beyond Organic, a much-needed initiative focused on combating food security, water scarcity, and sustainable land use. As part of the Emergency Resilience Program, KFAS facilitated a call for practical solutions to address the repercussions of the pandemic on national food security and supply chain disruptions. Beyond Organic has emerged as a local pioneer, supplying innovative agricultural technologies to the Kuwaiti market, with a particular focus on aeroponics to optimize crop cultivation in Kuwait's challenging conditions.

One such successful collaboration was between researchers from Kuwait University and the London School of Economics and Political Science (LSE), aiming at providing quantitative data essential for informed urban planning. This project, under the Kuwait Academic Collaborations Programme, sought to unravel the patterns of land use, car reliance, urban sprawl, and spatial segregation that characterize Kuwait's current landscape. It has created a considerable dataset that would be useful for further researchers.

KFAS' dedication to addressing national challenges has led to the funding of research projects aimed at tackling infrastructural failures caused by extreme weather conditions and unusually high volumes of rainfall. This research delved into finding solutions to the problem of moisture damage. The

outcomes also included a workshop designed to transfer the knowledge gained.

Committed to fostering a sustainable Kuwait through knowledge, KFAS has provided funding for research poised to revolutionize the country's agricultural landscape. In collaboration with the Kuwait Institute for Scientific Research (KISR), KFAS is supporting initiatives aimed at establishing an inland shrimp farming industry. This endeavor not only aligns with Kuwait's climatic conditions but also holds the promise of enhancing food security and diversifying incomes for local farmers.

As KFAS continues to be a catalyst for positive change, its multifaceted endeavors, spanning education, urban planning, agriculture, and infrastructure, underscore a holistic commitment to securing Kuwait's prosperous and sustainable future.

Ameenah Farhan
Director General

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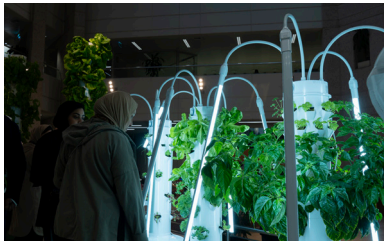
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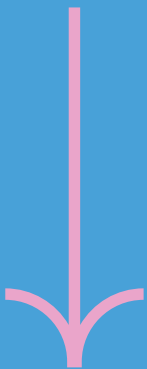
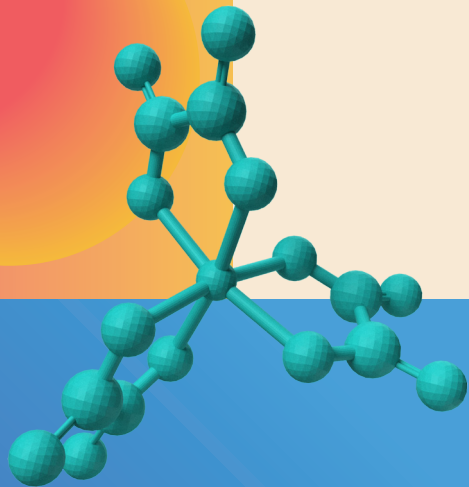
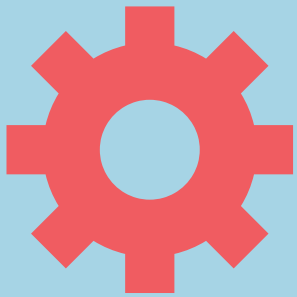
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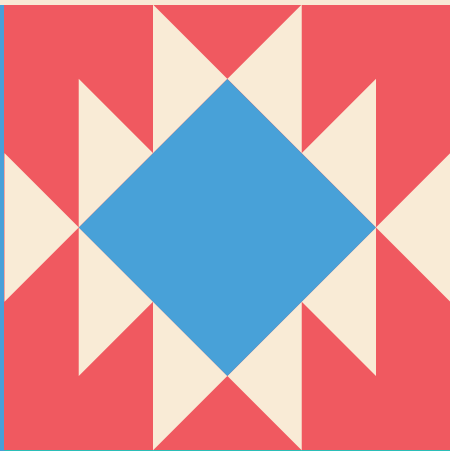


The Future of Kuwaiti
Aquaculture

Thanks to new research done
on a semi-commercial scale,
the country is one step closer to
establishing an inland shrimp
farming industry



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Kuwait’s First-Ever Ghabgathon

When professors at KCST introduced ghabga traditions to a hackathon-style competition last Ramadan, the event was a huge success

By Marianne Dhenin

Each Ramadan in Kuwait, ghabgas bring together colleagues, friends, and families to share gratitude, joy, and plenty of food and sweets. This year, professors at the Kuwait College of Science and Technology (KCST) had a novel idea — why not add learning tech skills to the list of ghabga activities? The result was “Ghabgathon,” a mashup of the words “ghabga” and “hackathon.”

“Our idea was to teach students how to code using different programming languages, build applications, and do web design,” said Basil Alothman, assistant professor of cyber security at KCST and one of the event organizers. Alothman and his colleagues devised a five-day-long event for college students to come together after iftar to learn these skills, make new friends, and enjoy ghabga cuisine.

The first-ever ghabgaton was hosted at KCST this year with support from the Kuwait Foundation for the Advancement of Sciences (KFAS). It attracted more than 50 students from universities nationwide and some from universities abroad who were visiting home during Ramadan. Alothman said the students were excited about the networking and learning opportunities at Ghabgathon. “They were interested in learning about developing applications and programming,” he said.

When students arrived at KCST for the first evening of Ghabgathon, they were divided into several groups to develop projects and compete for prizes. “The students had the freedom to choose whatever projects they wanted,” said Alothman. This freedom resulted in several creative



Basil Alothman

projects, including a mock-up mobile application to help students study for exams using artificial intelligence and a website that offers guidance to graduating high school students on which Kuwaiti universities and majors best match their interests. When students were not hard at work on their projects, they also enjoyed presentations and workshops with top engineers and experts.

Students presented their results on the final night of Ghabgathon, and a committee of experts selected prizewinners. Alothman said those who went home without a top prize still translated their Ghabgaton experience into success, “One student told me they asked him in a job interview, ‘What is Ghabgathon?’ and when he told them, they immediately offered him the job because they knew he had the skills.”

After the success of Ghabgathon 2023, Alothman said he and his colleagues plan to organize the event

again next year. They will keep a similar structure but want to attract more students from universities that were underrepresented in the first year. There is no need to change the event too much, Alothman said. They already have a winning formula: “Eat, learn, code.”

Our idea was to teach students how to code using different programming languages, build applications, and do web design

Beyond Organic



One of the major environmental challenges facing Kuwait and the region is food security, water scarcity, and sustainable land availability. An example of a local initiative that is taking on these challenges is Beyond Organic, a project that focuses on supplying innovative agricultural technologies to the Kuwaiti market.

As part of the Emergency Resilience Program, the Kuwait Foundation for the Advancement of Sciences (KFAS) launched a special call for practical solutions that addressed the implications of the pandemic on national food security and supply chain disruption. Beyond Organic was one of the companies that stood out in terms of commitment, dedication, and ambitious vision.

Through dedicated testing and experimentation, it successfully validated the viability of aeroponics within Kuwait’s challenging conditions and managed to cultivate nutrient-rich crops

while minimizing water consumption and decreasing reliance on chemical pesticides.

Aeroponic farming is a soilless method of farming, where the roots of the plants are hanging in the air 24/7. The nutrients come from a specially formulated 100 percent natural mineral solution called “TowerTonic”, used for all types of plants. With this technology, crops can grow larger in size, more aromatic, and fresher tasting with zero pesticides and chemicals.

Beyond Organic addresses the modern-day challenges of traditional farming by utilizing a fraction of the water required by conventional farming. This efficient water usage significantly contributes to sustainable water management in Kuwait, where water scarcity is a critical concern.

“The Beyond Organic Vertical Farm project was an exemplary practical solution to showcase the benefits of

combining protected agricultural with modern technologies,” said Husain Al Helal, Program Officer in the Research Directorate at KFAS. “Our partnership is part of KFAS’ vision for a sustainable future for Kuwait to catalyze the change needed in the country to foster its future development and long-term sustainability.”

Beyond Organic collaborated with experts to better the understanding of the technology and applications within the unique context of Kuwait’s environment and agriculture. A significant milestone was marked by the establishment of a pilot tower farm greenhouse comprising 135 showcase tower systems in Al-Wafra.

The technology of aeroponic farming is a new concept, especially in Kuwait and the Middle East region. As part of its efforts for a sustainable future, Beyond Organic prioritizes community engagement and awareness, by initiating educational programs about the benefits of the technology for the environment and future of Kuwait. The main aim is to empower the next generation with the knowledge and enthusiasm needed to embrace sustainable farming practices.

In addition, aeroponic farming enables the production of crops all year around with no downtime, and this is thanks to the automated climate-controlled environment that aeroponics use.



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Learning Through Play at Maharat Camp

A new summer camp takes advantage of the amenities at The Scientific Center, Kuwait, to create unique learning experiences for students and teachers alike

Last September, the Scientific Center, Kuwait (TSCK) erupted with gasps and giggles as excited young students raced around its aquarium and discovery center. While the students conducted science experiments, told stories, and

played games, they also learned skills to help them catch up to grade level before school started. “The students were playing, but they were actually learning,” said Abrar Almoosa, acting Program Manager for



the Scientific Culture Directorate at the Kuwait Foundation for the Advancement of Sciences (KFAS). The activities were part of Maharat Camp, a two-week-long day camp for students ages 7 to 10 organized by KFAS, utilizing publications from the Advancement of Sciences Publishing and Distribution (ASPD), and held at the TSCK. The camp focused on teaching math, science, English, and Arabic based on learning gaps identified by the Kuwait Ministry of Education. Farah Alkhawajah, an elementary-level English teacher at a government school in Kuwait City, said she observed these learning gaps when her students returned to in-person learning after COVID-19 school closures. “Because of

COVID and the use of online technology, children used less paper and pencil, so their writing skills decreased,” Alkhawajah said. “Reading also wasn’t practiced much during COVID-19 because some parents didn’t have the ability to teach English or Arabic.” Almoosa said when her team began brainstorming ways to help students catch up, TSCK came to mind. “There are lots of resources there for hands-on activities and play-based learning,” she said. ASPD contributed learning materials on themes connected to the amenities at the TSCK. Alkhawajah was also an instructor at Maharat Camp. She used the aquarium and desert animal exhibition to teach her elementary-level English students. They

learned about letters using animal names and wrote stories about the creatures they encountered. “They graduated from the camp with much more knowledge than they would have from a regular classroom,” Alkhawajah said. For the instructors, too, working in a more creative environment was refreshing and allowed them to develop and test new approaches to teaching. “I loved that at Maharat Camp, we had the freedom to teach without strict regulations or rules,” Alkhawajah said. Even several months later, Almoosa said she still hears from teachers about how their experiences at Maharat Camp improved their classroom teaching. The program also provided learning opportunities for a third cohort: 15- to 17-year-old students who volunteered to help the instructors implement their lesson plans while practicing 21st-century skills. “We tried to push them to communicate, cooperate, learn leadership, and express themselves,” said Almoosa. Based on student surveys and instructor feedback, Maharat Camp was a huge success. It will be hosted twice in 2023. “The results were impressive,” said Almoosa. “It was great to see the major changes in students.”

The students were playing, but they were actually learning



KFAS launched its 2023 season of the Chief Science Officers Program

By Marianne Dhenin

The Kuwait Foundation for the Advancement of Sciences (KFAS) launched the 2023 season for the secondary level of the Chief Science Officers (CSO) program, in close partnership with Kuwait University,

from 9 to 19 July 2023, at the College of Life Sciences in Sabah Al-Salem University City (Al-Shadadiya). Layla Al-Musawi, Acting Director of the Scientific Culture Department, said that the program aims to motivate



students from the ninth to the twelfth grade to take an interest in the fields of science, technology, engineering and mathematics (STEM), and to enhance their abilities in scientific communication and dissemination of scientific knowledge in schools and society. It consists of many lectures, practical workshops, seminars and visits that contribute to making the voice of students heard, building their capabilities as leaders in various fields of science, and educating them about what is available to them as a professional future in the fields of science, technology, engineering and mathematics.

With the success of the program and its reverberations in the region, a delegation from the Rubu' Qarn Foundation for Creating Leaders and Innovators participated in the current season, the launch of which was announced in September 2016 under the generous directives of the wife of His Highness the Ruler of Sharjah,

Her Highness Sheikha Jawaher bint Muhammad Al Qasimi, President of the Rubu' Qarn Foundation for Creating Leaders and Innovators. It is the first Emirati, Arab and regional institution that aims to build an Emirati generation capable of leading and influencing the future, committed to its national identity. The participation of these female and male students came to enrich the CSO program, strengthen the principles of fraternity in the GCC countries, and provide new paths for cooperation, dialogue and work in the scientific field.

The season was opened by His Excellency Matar Hamed Al Neyadi, Ambassador of the United Arab Emirates to the State of Kuwait, where he reviewed the efforts of the sister country of the UAE to host the Conference of the Parties to Climate Change (COP28) for the year 2023, and its plans and programs that aim to achieve environmental, economic and social sustainability and the role of youth in the efforts in reducing climate

change and the interest of the United Arab Emirates and the presidency of the COP28 conference in allocating a track and spaces for young people in the Climate Summit Action Program. This interest came from the UAE's belief in the role of youth in complementing current efforts in achieving sustainability, accelerating emissions reduction, promoting innovation and developing technologies to benefit from all natural resources and reach carbon neutrality.

For his part, a member of the teaching staff at Kuwait University and the supervisor of the program, Abdullah Al-Failakawi, said that the training program was held this year at the College of Life Sciences at Kuwait University, under the supervision of a distinguished group of faculty from the various colleges at Kuwait University. Al-Failakawi added that through the program, the students prepared an integrated action plan to spread scientific knowledge and scientific enlightenment in their communities, and sought to implement it as individuals or as teams, indicating that in the course of all that, those in charge of the program were keen to enhance the spirit of cooperation among students, and to build a community of leaders that contribute to the consolidation of science in Kuwait.



Dhari Alrasheed

Mapping the Future: Uncovering Patterns and Trends in the Socioeconomic Landscape of Kuwait

The latest research into the economic and social landscape of Kuwait could help inform sustainable models of urban development in the future

Many countries are looking towards sustainable urban development, but one barrier to implementation is defining the patterns of land use that help inform future planning. Kuwait tends to be characterized by a heavy reliance on private cars, low-density urban sprawl, and limited use of public spaces. Another distinguishing factor of planning decisions in Kuwait is the spatial segregation of the population.

While there have been studies into this type of spatial segregation in Kuwait

in the past, these have mostly dealt with qualitative data. A new project, completed with support from the Kuwait Foundation for the Advancement of Sciences (KFAS), aims to uncover the kind of quantitative data that is needed to inform Kuwaiti decision-makers as they consider the future of urban planning.

The project is led by Dhari Alrasheed from Kuwait University and Nuno F. da Cruz from the London School of Economics and Political

Science (LSE). The project falls under the Kuwait Academic Collaborations Programme, run by the LSE Middle East Centre, with funds provided by KFAS.

Alrasheed is an Assistant Professor of Economics in the College of Business Administration at Kuwait University. His research activity spans the fields of urban economics and applied econometrics. He holds a doctorate and master's in economics from the University of California, Irvine, and a bachelor's in mechanical engineering

By Emma Stenhouse



from Oregon State University. Since joining Kuwait University in 2018, he has taught introductory and advanced courses in the economics undergraduate and master programs.

The goal of this specific project was for da Cruz, a researcher of urban governance, and Alrasheed to join forces and complement each other’s expertise and knowledge. “We’ve used multiple measures of segregation that are quantitative, and it seems like we are the first in Kuwait to implement them, and potentially in the Gulf,” Alrasheed said. “So we hope that complements the existing body of literature.”

The initial aim of the project was to gather data to uncover the nature of spatial segregation in Kuwait, which

could then also be used to discover more about spatial inequalities. “The spatial segregation data turned out to be much bigger than we thought,” said Alrasheed. As a result, the aim is to focus on spatial inequalities as a project for the future. “It felt more natural to first understand the nature of segregation before we are able to understand the spatial inequalities that potentially result from the segregation,” said Alrasheed.

The project started by using data from the census, which was collected in 2011. “A lot has happened since then,” said Alrasheed. While the latest census was completed during the first half of 2023, the spatial data wasn’t yet published. So, the project team used another dataset from the Public

Authority for Civil Information in Kuwait. Importantly, this data has been collected over the last 20 years, at five-year intervals. “Because of that, we were able to quantify segregation and how it changed over time, rather than just one snapshot,” said Alrasheed.

The biggest challenge of the project was getting the raw data prepared before it could be interpreted. Initially, Alrasheed intended to hire someone to prepare the data but due to lockdowns during the COVID-19 pandemic, this wasn’t possible. To get around this problem Alrasheed ended up collecting most of the data himself, plus learning the new software required to prepare the data.

The pandemic also impacted the project, which started towards the end

of 2019, in other ways. Due to travel restrictions, da Cruz wasn’t able to travel to Kuwait to conduct fieldwork as planned. “We ended up hiring local lead researchers who have done a phenomenal job for us, but it’s not the same as the principal investigator actually doing the work himself,” said Alrasheed.

Even 20 years ago, Kuwait was classed as having extreme segregation. However, the project uncovered that since then, segregation has increased. “While this can, in part, be explained by transient workers self-segregating, it’s also due to public policies,” said Alrasheed. Two of the most common measures of segregation are the dissimilarity index and the isolation

index. These measure how the population is distributed across space, and how this population experiences any segregation. But this project also looked at another three measures of segregation, to uncover far more detail than previous research.

“We combine these five indices of segregation, instead of just looking at one of them, to paint a complete picture of the segregation situation in Kuwait,” said Alrasheed. “And the conclusion is undeniable, that Kuwait is considered extremely segregated, probably due to a combination of policies and also behavioral choices.”

The full report is currently under review and expected to be published towards the end of 2023. As the project uncovered so much data, the next stage is to look at the effects of this spatial segregation in more detail. Alrasheed hopes to uncover whether the uneven distribution of the population correlates with an uneven distribution of resources.

The project has created a considerable dataset, that Alrasheed also plans to make available for other projects. “That would be like a spillover effect or further kind of benefit from this project, that it would produce more research for a much lower cost,” he said. Another positive aspect was the opportunity to collaborate with experts from other disciplines, especially as Alrasheed is one of the only urban economists in Kuwait. He also said how fortunate researchers like he and da Cruz are, to be able to access KFAQ funds through the LSE Middle East

Center. He also mentioned the integral role of researchers Muneerah Alrabe and Abdullah Al-Khonaini, who worked as consultants on the project. “We wouldn’t be able to do much of the work without their help. I’ve known them personally before, but I’ve never had the chance to work with them” Alrasheed said. “And now that I have, I’m actually excited to work with them more in the future.”

Even though the project took longer than anticipated to complete, Alrasheed has enjoyed the opportunity to learn more about his home country: “Being a Kuwaiti researcher educated abroad, I’ve underestimated how much there is to be known and to be learned about Kuwait and its history,” Alrasheed said. “It’s been a blessing learning about some of the history of urban development in Kuwait through this project, and the status of society and where we stand when it comes to the interaction between the Kuwaiti population and the huge non-Kuwaiti population that is an integral part of society.”

And the conclusion is undeniable, that Kuwait is considered extremely segregated, probably due to a combination of policies and also behavioral choices



Taha Ahmed

Unraveling the Future of Kuwaiti Roads

Over the course of ten days in November 2018, Kuwait found itself on the receiving end of unprecedented storms. In just a single day, parts of the country received as much rain as they typically receive in three months. Roads became impassable rivers; schools closed, and the asphalt deteriorated; the Minister of Public Works

pointed out the need to address the infrastructural failures. “The roads have been deteriorating since 2013,” said Taha Ahmed, Associate Professor at the College of Engineering at Australian University-Kuwait. “But all the solutions presented are not really fixing the problem. They are just painkillers.”

Ahmed has endeavored to tackle these infrastructural challenges head-on in his extensive research project, “Effect of Raveling on the Performance of Hot Mix Asphalt under Arid Climatic Conditions: Case Study in Kuwait.” The phenomenon in question - raveling - occurs when aggregates dislodge themselves from the top layer of the asphalt pavement; this deterioration not only undermines the structural integrity of the roads, but also produces the “flying gravel” that inflicts itself on so many vehicles in Kuwait (especially after a bout of rain). Faced with the task of maintaining roads in an increasingly unstable climate, Kuwait may serve as an ideal (albeit unwilling) laboratory for road design.

Ahmed and his team conducted the project - funded by the Kuwait Foundation for the Advancement of Sciences (KFAS) – in three phases: “Post-mortem Evaluation of In-service Pavements”; “Implementing the Superpave Mix Design Method for Kuwaiti Roads;” and finally, “Performance Life using Mechanistic-Empirical Analysis of Asphalt Mixtures.” The first phase, “Post-mortem Evaluation,” took core samples of five select pavements throughout Kuwait City and assessed them for a range of distress: cracking, potholes, rutting, and raveling.

“Imagine a deterioration curve. For the first few years, it will deteriorate - but not as fast. But at a certain level? There is a breaking point when the pavement cannot really take it anymore,” Ahmed said. “[But] you should reach that point after twenty years. Some places here,

reached that point after fifteen years, five years, sometimes three years from their last known maintenance. Can you imagine that?”

Ahmed’s research greatly benefited from the partnership with his graduate alma mater, University of Nevada, Reno; Ahmed’s master’s degree supervisor, Elie Hajj, actually served as the co-investigator (along with Ahmad Said Saad, Ahmed’s colleague at Australian University-Kuwait). After Ahmed’s undergraduate students collected and prepared both core and laboratory asphalt pavement samples in Kuwait, they would ship them to Aditya Singh and Sitharththan Arunthavabalan, from the laboratory team at University of Nevada, Reno for analysis with specialized advanced equipment not available in Kuwait.

Much of the asphalt’s rapid deterioration can be traced back to moisture damage; excess water ends up stripping away the adhesion between the asphalt’s aggregate and the asphalt binder (bitumen), which results in the raveling. Kuwait’s recent rainstorms, however, have begun to exceed even the “Al-Haddama” rainfall of 1934, when Kuwait witnessed heavy rains amounting to about 300 millimeters, which is three times the usual rainfall amount. It led to the destruction of more than 500 mud houses, displacing 18,000 people. How does one prepare modern roads for this new climactic era? Ahmed addresses a possible solution in the second component of his research, “Implementing the Superpave Mix Design.”

Superpave is an evolution of asphalt chemistry that hopes to replace the “Marshall mix” - the classic asphalt type that coats roads across the world, but whose formula predates World War II. In a long-overdue improvement, Superpave design aims to include traffic load and climate into its formula, to better control the three major stresses that undermine asphalt: permanent deformation, fatigue cracking, and thermal cracking. This new design - already in use in Qatar - is designed to withstand temperatures as high as seventy-six degrees Celsius (sixteen degrees higher than the Marshall mix). This newfound strength depends on a careful combination of four major components: aggregate, binder, air voids, and additives.

One hurdle to implementing this new mix design in Kuwait, however, is that the country actually does not produce the grade of bitumen required to create adequate binder. Missing this critical ingredient, Ahmed’s team mixed the binder with three percent polymer in order to meet Superpave expectations.

There are, of course, other major factors that contribute to road deterioration, such as traffic load - especially in a country where eighty percent of all vehicles are privately owned. One of Ahmed’s previous projects, “Improving the Traffic Flow in Hot Arid Climate Areas by Implementing a Monorail Light Rail Transit System: Case of Kuwait,” suggested that a small length of Gulf Street monorail track could reduce traffic load by as much as fifty percent.

By Jonathan Feakins



The final stage of Ahmed’s research, “Performance Life using Mechanistic-Empirical Analysis,” attempted to determine if this modified Kuwaiti Superpave mixture would truly be up to the challenge of surviving twenty years in Kuwait’s intense conditions. And in some respects, it absolutely did, particularly with regard to avoiding permanent deformation. Likewise, the new mix could withstand thermal cracking - because, while recent temperatures in Kuwait have reached as high as fifty-four degrees, such heat is still safely within the pavement’s design specifications. (The pavement’s temperature tolerance does have a lower threshold, as well - but

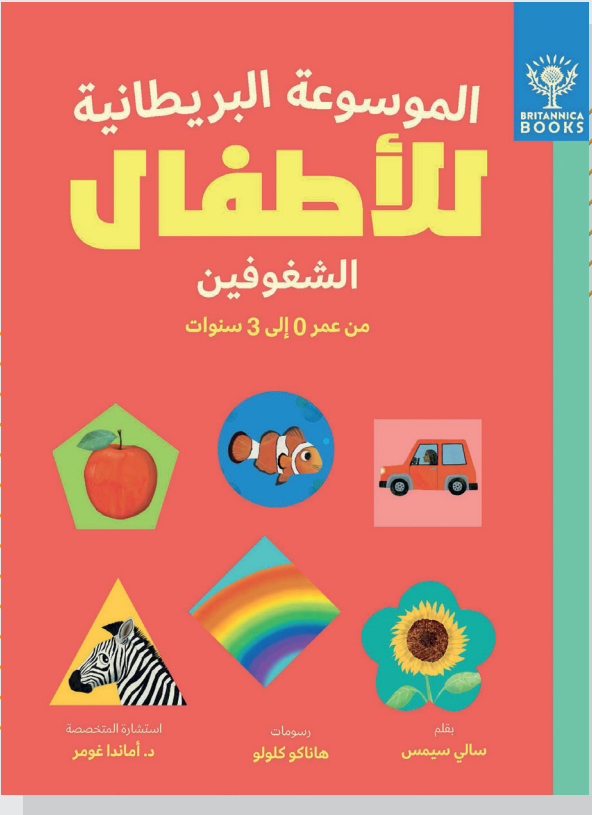
that threshold is far more frigid than Kuwait ever expects to experience.) The Achilles–heel of this new mix, however, is poor resistance to fatigue cracking. Although its life could be extended for several years by reducing the performance criteria five to ten percent, Ahmed and his team project that the modified Kuwaiti mix – in its current state – could be expected to last only five or six years. Kuwait’s recent flooding, in particular, plays an outsized role in this strain. “When you address the problem of moisture damage,” Ahmed said, “It will actually perform very well.” The entire project culminated this

past February, in a two-day workshop organized by Australia University-Kuwait and University of Nevada, Reno. The workshop drew almost two hundred participants, from government engineers and private sector workers to students, all of whom represented what Ahmed describes as a “very good, and productive project between us and the Ministry of Public Works, in addition to our international collaborators.” “Research, without the transfer of knowledge, is nothing,” Ahmed said. “It will just be sitting there.”

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The Future of Kuwaiti Aquaculture

Thanks to new research done on a semi-commercial scale, the country is one step closer to establishing an inland shrimp farming industry

By Marianne Dhenin

Through the project, we increased the survival rate to 72 percent

With its hot summers and sandy soil, Kuwait is ill-suited to agriculture. However, the nation's climate is well-suited to certain forms of aquaculture, including shrimp farming. With this in mind, researchers at the Kuwait Institute for Scientific Research (KISR) began studying aquaculture in the 1970s. The institute believes that scaling up shrimp farming in Kuwait could improve the nation's food security and diversify incomes for local farmers.

Early research on shrimp farming at KISR concerned coastal farms, where shrimp are raised in their natural saltwater habitat. However, Kuwait has limited coastline real estate, and most farmers operate on inland properties,

so in 2015, KISR began exploring opportunities for inland shrimp farming. "We wanted to create opportunities for the small- to medium farms located in the inland area," said Sherain Al-Subiai, an associate research scientist in the mariculture and fisheries department at KISR.

Operating inland shrimp farms presents a host of challenges. The most significant is that groundwater is ill-suited to shrimp farming because it lacks certain elements of seawater that shrimp depend on to survive. This is the issue that Al-Subiai and her colleagues at KISR have been working to overcome through years of research and experimentation. "There are many elements in seawater, which must be looked at one by one," said Al-Subiai. By adjusting things like magnesium, potassium, and sodium, researchers can make groundwater mimic saltwater and thus create a suitable habitat to foster shrimp far from the coast.

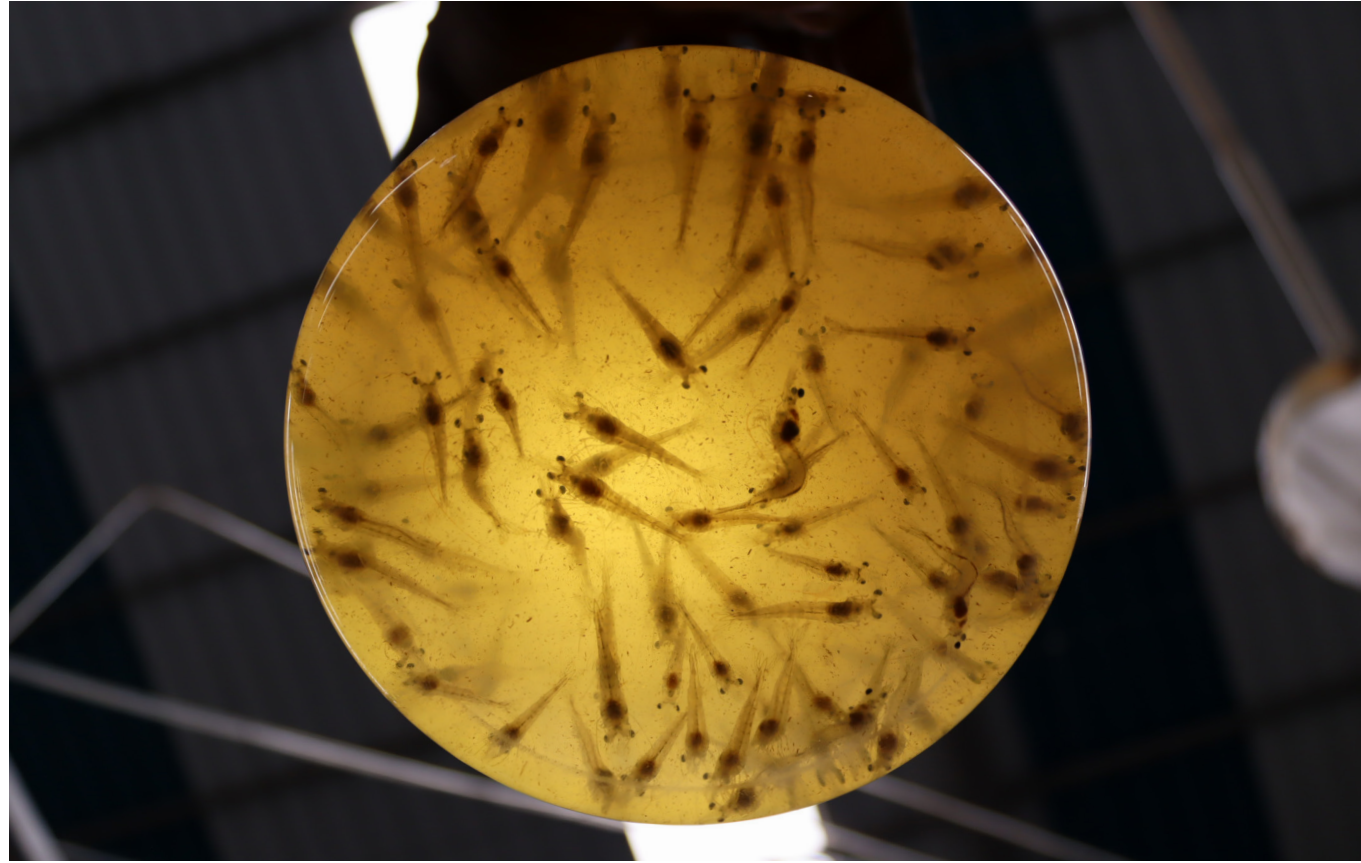
Kuwaiti aquaculture research on a new scale

The aquaculture team at KISR had its most significant leap forward in 2019 when the Kuwait Foundation for the Advancement of Sciences (KFAS) gave them a two-year grant to help fund a new research site and conduct experiments on a semi-commercial scale. "Usually, we do our experiments on a small scale at the institute. But I wanted to have data that could be applicable for the commercial sector, and for that, I needed to work at a semi-commercial scale," said Al-Subiai.

The team established their new research site at Kabd, about 40 kilometers outside Kuwait City and at least 30 kilometers from the nearest coast. It has both outdoor and indoor facilities. The indoor facility hosts a pair of circular tanks where shrimp live during the nursery stage, after they have hatched and before they are large enough to be moved into ponds where they can grow to their full size. There are also three 75-square-meter flow-through systems or raceways located indoors, where shrimp can be cultured at a high density. Outside, there are a pair of earthen ponds, sized 1,500 square meters, also used during the grow-out phase.

Funding from KFAS also allowed researchers to purchase supplies needed to operate the research, including imported shrimp feed, imported shrimp larvae, and various test kits to monitor water quality at the research site and ensure the shrimp were free from diseases. "Without KFAS' support, this project would not have been possible," said Al-Subiai.

When the research team began its work, the survival rate of shrimp, meaning how many shrimps stay alive until they're large enough to be harvested, was less than 20 percent. "Through the project, we increased the survival rate to 72 percent," she said. "It is a massive increase." The new survival rate is also much closer to the rate achieved on saltwater farms, which usually measures about 80 percent. Other measurements of success are also on par with what researchers expect on an inland shrimp farm.



The future of inland shrimp farming

After two years of KFAS-funded research at Kabd, Al-Subiai is preparing her findings for publication. The results will be published in a major aquaculture journal. For the next stage of their research, Al-Subiai said the team plans to study minor elements, like zinc and copper, which can affect how large the shrimp grow before harvest. The team is also looking for alternatives to replace the expensive salt they add to their water with something less costly and more environmentally friendly.

In the future, this research, Al-Subiai said, could also be applied to farming species of shrimp native to Kuwait. Using

native species would decrease the need to import shrimp larvae, making shrimp farming more profitable. The native species are also more popular among local consumers.

A final obstacle to scaling up inland shrimp farming in Kuwait is the lack of know-how among local farmers, but Al-Subiai and her team are addressing this too. With on-site training courses at the Kabd research site, the KISR team prepares farmers to become the first generation of inland shrimp farmers in Kuwait. They offer one training course for beginners and one for those with existing knowledge each year. Course objectives include ensuring farmers understand the infrastructure of an inland shrimp

farm, know how to test and adjust water quality, and can diagnose and treat common diseases in shrimp.

With these next steps for the research team and growing interest in training courses each year, the future of shrimp farming in Kuwait is promising. “If you had asked me five years back, I would have said it was impossible to culture shrimp inland,” said Al-Subiai. Today, however, thanks to the determination of the research team at KISR and funding from KFAS, she said, “It is possible, and we can do it in Kuwait.”

