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CRUDE

Magazine



منظمة إستدامة الوطن
Istidama Wattan Organization



Climate & Sustainability Ambassadors
سفراء المناخ وإستدامة - النسخة الثالثة



University of Khartoum
SPE Student Chapter

EDITION WORD

It has been a year since we released the first edition of our magazine. Over this past year, we faced many challenges that prevented us from publishing as regularly as we had hoped. Yet, each challenge brought valuable lessons. Despite the difficult times our beloved country endures – marked by the attacks of barbaric militias, injustice, and devastation – we continue to stand firm. We do our best to support ourselves, our brothers and sisters, and the generations to come, by building a foundation of knowledge that can be shared, preserved, and expanded upon.

In this edition, we shed light on the impact of climate change in Sudan, a reality that has affected our families through floods, heat waves, dust storms, and more. We also discuss the energy challenges that arise from these conditions, and how sustainability can be applied across various sectors, particularly in oil and electricity.

I hope this edition enriches your knowledge, fuels your curiosity, and inspires you never to give up on learning. May you become one of the sparks that illuminate the future of our nation. May God bless you all and our efforts for a brighter tomorrow.

When I think about engineering, I don't see a world divided into black and white — those who care about sustainability and those who don't. Over the years, through study and real-life exposure, I've come to see engineering as deeply connected to the world around us. Every technical decision carries an environmental, social, and even ethical dimension. This is especially true when we explore the intersections between the petroleum sector and the environment — the focus of this edition of 249 Crude.

As COP30 approaches and environmental dialogues grow louder, it's important to realize that our discipline isn't isolated. Whether you work in petroleum, renewables, or any other field, your priorities shape your impact. Balancing energy development with sustainability isn't an argument of "either-or"; it's a continuous journey of redefining what responsible engineering means.

I'm proud to present this issue, created alongside ongoing environmental initiatives and collaborations. I hope it inspires you to think, reflect, and find your own balance in the dynamic equation of energy and sustainability.



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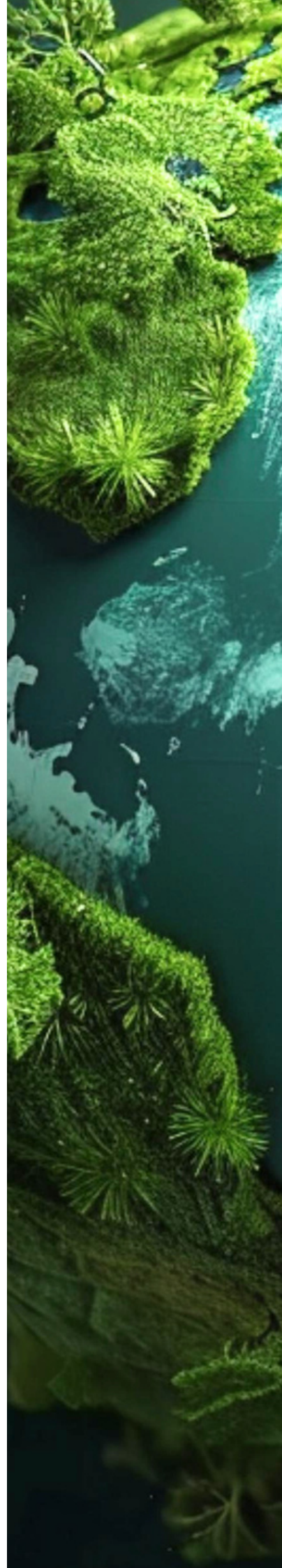
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AI FOR A GREENER FUTURE

HOW ARTIFICIAL INTELLIGENCE CAN HELP PREDICT OIL PIPELINE RISKS IN SUDAN

In Sudan, oil has long been both a gift and a challenge. It fuels much of the country's economy, provides jobs, and supports national development. But behind that progress lies a silent problem: the environmental risks caused by oil spills and pipeline failures. These incidents don't just harm the land, they affect water resources, agriculture, and the health of nearby communities. With most of Sudan's infrastructure facing challenges such as poor maintenance, limited monitoring systems, and economic restrictions, finding a smarter, cost-effective way to protect the environment has never been more urgent.

This is where Artificial Intelligence (AI) enters the picture. Across the world, AI is transforming industries by analyzing large sets of data and predicting problems before they happen. In the energy sector, it's already being used to forecast demand, detect leaks, and improve operational safety. For Sudan, integrating AI into its oil pipeline network could mark a turning point, one where technology helps prevent environmental disasters instead of responding to them after the damage is done.

Imagine an intelligent system that continuously monitors the pressure, temperature, and flow rate in Sudan's pipelines. When a pattern looks suspicious, perhaps a sudden pressure drop or a temperature spike, the AI system immediately alerts engineers before a leak happens. Instead of waiting for a visible spill, the system predicts risks days or even weeks in advance. This kind of predictive monitoring can save millions of dollars in repairs, protect local ecosystems, and prevent harm to nearby communities who depend on clean soil and water.

To understand how AI can achieve this, it helps to know what makes pipelines fail. In Sudan, pipelines often face corrosion from humidity, shifting soils, and temperature fluctuations. Add to that poor access to modern sensors and delayed maintenance, and you have a recipe for leaks. Traditional inspection methods rely heavily on human workers traveling long distances, checking pressure readings manually, and reporting issues to central offices. But with AI, the process becomes far faster and more reliable. Smart sensors send real-time data to a central system, where algorithms trained on years of historical information can detect early signs of failure.



For example, machine learning models (a branch of AI) can be trained using data from past incidents. They can learn what combinations of readings usually lead to a leak or rupture. Once trained, these models can analyze current data and predict which sections of the pipeline are at highest risk. This means maintenance teams can focus on those areas first, saving time and reducing unnecessary work. In addition, satellite imagery and drone-based AI can help detect changes in soil color, vegetation, or temperature that might indicate underground leaks, even in remote desert areas.

Now, one might ask: why Sudan? The country offers a unique and realistic simulation model for testing how AI can operate under challenging conditions. Sudan's oil infrastructure covers large distances, often across deserts and floodplains. Monitoring such networks manually is expensive and time-consuming. Moreover, Sudan faces economic and logistical hurdles that make it hard to adopt fully automated Western-style systems. That's what makes it a strong model for low-cost AI-based solutions, ones that rely on open-source technology, locally trained engineers, and cloud-based analytics instead of expensive imported hardware.

Imagine a pilot project in Sudan where AI models are trained using limited but high-quality data from just a few pipeline segments.

Engineers could then use those models to predict failures across a much larger network. Over time, as more data is collected, the AI system becomes smarter, more localized, and more accurate. It could even incorporate data on rainfall, temperature, or soil moisture to understand environmental pressures on the pipelines. By connecting such systems with local universities or energy organizations, Sudan could become a leader in affordable, sustainable AI innovation across Africa.

The environmental impact would be massive. Each year, even a small oil spill can destroy farmland, poison rivers, and displace families. Preventing just one large spill would save enormous amounts of money and resources. Beyond that, AI-driven maintenance reduces unnecessary fuel use for repair trucks and prevents emergency burn-offs, lowering greenhouse gas emissions. In short, it's a win for both the economy and the environment.

Of course, this vision isn't without its challenges. Sudan faces technical limitations, including unreliable internet access in remote areas and a shortage of skilled data scientists. There are also institutional barriers, such as limited collaboration between technology companies and the energy sector, and the absence of national policies promoting AI in environmental protection. However, these challenges shouldn't be seen as barriers, but as opportunities for innovation.





International partnerships, student-led research initiatives, and training programs can fill the gap. For example, university chapters like the Society of Petroleum Engineers (SPE) at the University of Khartoum can collaborate with global AI and sustainability organizations to create small-scale experimental models. These can demonstrate how predictive maintenance saves costs and protects nature, encouraging policymakers to adopt such systems nationwide.

The key to success will be collaboration. AI is not magic, it depends on data, human expertise, and consistent monitoring. Governments, universities, and energy companies must work together to build the digital infrastructure required for AI to function effectively. Cloud computing platforms like Google Cloud or open-source tools such as TensorFlow can be used to process large data sets affordably. Meanwhile, local engineers and environmental scientists can focus on fine-tuning the models to fit Sudan's conditions, ensuring that the technology doesn't just copy Western solutions but adapts them for local realities.

Beyond the technical benefits, this transition represents something deeper: hope for a greener future. AI has the potential to transform Sudan's oil industry into one that aligns with global sustainability goals. By reducing spills, improving efficiency, and minimizing environmental damage, Sudan can show that developing nations don't need to choose between economic growth and environmental care, they can achieve both through smart, data-driven systems.

The story of AI and oil in Sudan, then, is not just about machines and algorithms. It's about people, the engineers who build the systems, the students who analyze the data, the farmers whose lands remain safe, and the children who grow up near cleaner rivers. It's a story of transformation powered by knowledge, innovation, and care for the environment. As global attention shifts toward sustainable energy practices, Sudan's use of AI in its oil industry could become a model for other developing countries with similar challenges.

In the end, artificial intelligence is not replacing humans, it's helping them make better decisions, faster and more accurately. It allows us to predict instead of react, to protect instead of repair. And in a country like Sudan, where every drop of oil and every patch of green land counts, that makes all the difference.

AI may not solve all environmental problems, but it gives us a fighting chance to create a smarter, cleaner, and more sustainable energy future, one prediction at a time.

FROM DATA TO DIALOGUE

HOW VOLUNTEERING AT COY SHAPED MY CLIMATE LEADERSHIP

When I first heard about the opportunity to volunteer for COY19 - Azerbaijan version as part of the Research and Reporting Office, I couldn't contain my excitement. It felt like the perfect blend of my passions for sustainability and climate action, combined with the chance to contribute to something truly global. I remember our first virtual meeting, where I was surrounded by people from all over the world, each with their unique perspectives and ideas. We were all so different, yet united by one common goal: to ensure that youth voices would be heard loud and clear at COY19. I was assigned to the Research and Reporting Office, which, as the name suggests, meant exploring policies, reports, and data in depth.

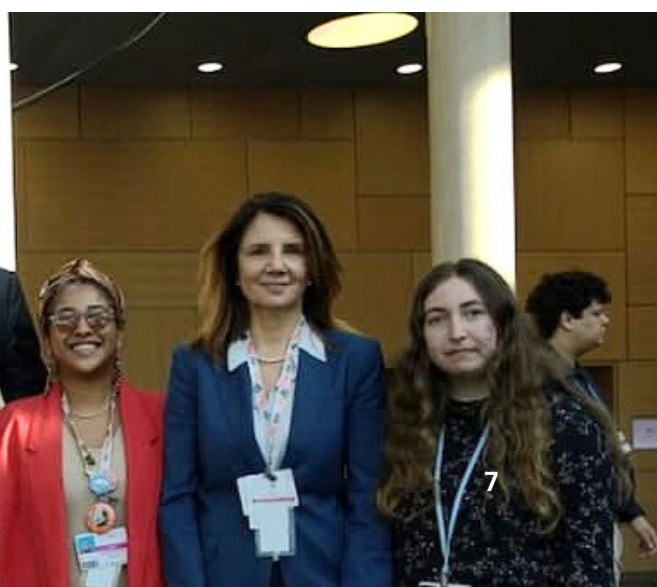
After COY19, I joined YOUNGO spots again but this time as part of Media Office for COY20— Belem Version “ a completely different but equally exciting experience. This time, I wasn't just behind the scenes researching; I was helping shape how our message reached the world. The meetings were more intense, the discussions were deeper, and the negotiations were more dynamic, hearing stories of climate crises from volunteers of different backgrounds made me realize how powerful youth can be when united for a common cause.

From crafting posts to supporting coverage of major tools for the Conference Delegates, every task in the Media Office required creativity, coordination, and precision. It was also the year I joined the Logo Selection Committee, where I had the incredible opportunity to help select the official COY20 logo, a small but meaningful contribution that symbolized the spirit of youth climate advocacy.

Conferences Preparation gives you under pressure skills I remember that day when I received a shoutout from the YOUNGO community for stepping in to help the Policy Team at the last minute. In less than 24 hours, we designed the entire YOUNGO SB62 Position Paper, a document that reflected months of hard work by policy volunteers.

I also learned so much from the incredible Roaa Alobaid, who has been a true inspiration to me. From organizing Google materials to managing meetings and reporting, Roaa shaped the way I work and lead. This year, after co-founding United Beyond Borders, she was a COY20 Liaisons. Her leadership skills and guidance continues to leave a lasting mark on my journey.

At the end of the day, volunteering isn't about observing your faults or earning a salary, it's about the good messages you help deliver, the impact you create, and the benefits others gain from your efforts when you are doing them with sincerity





INTERVIEW WITH DR. ASIA

A DECADE OF YOUTH LEADERSHIP FOR SUSTAINABILITY IN SUDAN

In this special feature, we sit down with Dr. Asia, the Secretary General and Founder of the Iskudamatvatan Organization, to discuss her inspiring journey in advancing sustainability and youth empowerment in Sudan. Over the past decade, she has worked tirelessly to create platforms that connect young people with global opportunities and foster a culture of responsibility and innovation.

What was the defining moment that led to the establishment of the Sustainability initiative?

The defining moment came when I realized the absence of a clear understanding of sustainable development, and the lack of a national youth platform to discuss and implement programs related to the global goals.

The first major challenge was the limited early engagement of youth and society with the initiative. It took eight years of continuous effort to reach the first milestone: training and empowering young people, and launching a capacity-building program focused on the Sustainable Development Goals (SDGs).

What has motivated you to continue empowering youth in this field?

A deep sense of national and moral responsibility has been my driving force. I believe in the potential of Sudanese youth and their right to be connected with the international community, to showcase their capabilities and to gain exposure to global experiences.

To ensure the continuity of youth-led initiatives, I believe there is an urgent need for a Sustainability and Climate Action Fund dedicated specifically to youth. Such a fund would secure their essential needs and enable long-term impact.

How do you view the role of Sudanese youth in the current context?

Sudan is blessed with vast strategic resources. The most valuable among them is its youth. They represent the largest, most dynamic, and most influential segment of our population.

Even amid the ongoing conflict, Sudanese youth have demonstrated extraordinary resilience. During the war, youth-led initiatives successfully addressed major challenges and provided critical support across the country. Their ability to adapt and lead in times of crisis is a powerful reminder of their potential to drive national progress.

What qualities have you observed among youth over your ten years of experience?

After a decade of working in this field, the most remarkable qualities I've observed among young people are their ability to manage diversity, embrace inclusion, and accept others, even in difficult conditions.

Their resilience, ambition, and passion stand out as defining traits. These qualities not only sustain their efforts but also ensure the successful implementation of advanced and forward-looking strategies.

Finally, what message would you like to share with Sudanese youth?

My message to youth centers around national leadership. Through it, we can create a lasting impact on global leadership. Sudan is a promising nation, and its youth are an undeniable force, regionally, internationally, and across Africa, a continent rich with untapped opportunities.

Let youth be the hope and the example, the builders of a sustainable future through knowledge, unity, and strong partnerships. These are the pillars for achieving a green transition and creating opportunities for the next generation. Together, we can build a safe, sustainable, and prosperous homeland.

THE FIRST COMMERCIAL HYDROGEN-POWERED AIRCRAFT

A New Era of Clean Aviation Fuel Begins

In 2020, Airbus announced an ambitious dream: the ZEROe Project, a vision to build the world's first commercial aircraft powered entirely by hydrogen. Many viewed it as science fiction, but just five years later, the dream started to take shape. By 2025, Airbus successfully demonstrated hydrogen fuel cells capable of powering an aircraft's propellers while producing zero carbon emissions. The only by-product? Pure water.

This achievement wasn't just about innovation; it marked a turning point in aviation history. For over a century, airplanes have relied on fossil fuels, efficient but dirty. Hydrogen, on the other hand, offers a chance to rewrite that story, ushering in an era of clean skies and sustainable flight.

Hydrogen: The Clean Fuel of the Future

Hydrogen is the most abundant element in the universe, and now it's being recognized as one of the most promising fuels for a low-carbon world. When hydrogen is used in a fuel cell, it combines with oxygen to generate electricity, with water vapor as the only emission.

Unlike traditional jet fuels, hydrogen doesn't emit carbon dioxide, sulfur, or particulates. This means cleaner air, reduced climate impact, and quieter aircraft. Beyond aviation, hydrogen is already helping transform industries, powering cars, storing renewable energy, and fueling factories.

In essence, hydrogen is not just a fuel; it's a

bridge to a sustainable energy system that connects clean power generation, transportation, and industry.

How Is Hydrogen Produced?

There are several ways to produce hydrogen, but two main methods stand out today:

1. Water Electrolysis

Electricity is used to split water (H_2O) into hydrogen and oxygen. When this electricity comes from renewable sources like solar or wind, the result is green hydrogen — the cleanest and most sustainable form. It's essentially turning sunlight and water into usable fuel.

2. Steam Methane Reforming (SMR)

This traditional process extracts hydrogen from natural gas. While it's efficient, it emits carbon dioxide. However, when paired with carbon capture and storage (CCS) technologies, it becomes blue hydrogen, a transitional solution toward a fully green future.

Both methods play a vital role in scaling hydrogen production while the world transitions away from fossil fuels.

Key Advantages of Hydrogen

Hydrogen offers a combination of benefits unmatched by most other fuels:

Zero emissions: When used, hydrogen releases only water vapor, making it one of the cleanest energy carriers available.





High energy density: Hydrogen packs nearly three times more energy per kilogram than gasoline or jet fuel, allowing for longer flights and lighter aircraft.

Versatility: It's not limited to planes, hydrogen can power cars, ships, trains, and even entire cities.

Renewable potential: Green hydrogen links directly with renewable energy sources, helping balance solar and wind fluctuations.



Modern Applications and Emerging Technologies

Land Transport:

Companies like Toyota, Hyundai, and Renault have launched hydrogen fuel-cell vehicles (FCEVs) that refuel in minutes and can travel over 600 kilometers with zero tailpipe emissions. These cars are slowly making their way into public fleets and logistics systems around the world.

Clean Power Generation:

Hydrogen-based power plants are being tested in countries such as Germany, Japan, and the United States. These plants use hydrogen to generate electricity, reducing dependence on coal and oil while ensuring grid stability during renewable fluctuations.

Green Aviation:

The Airbus ZEROe project aims to deliver a fully hydrogen-powered commercial aircraft by 2035. Engineers are experimenting with both hydrogen combustion (burning hydrogen in modified engines) and fuel-cell propulsion (using hydrogen to create electricity). If successful, this could cut aviation emissions by up to 75 percent globally.

Renewable Energy Storage:

Hydrogen can store excess renewable energy for weeks or months — something batteries can't do efficiently. It acts as a natural energy "vault," releasing clean power when the sun doesn't shine or the wind doesn't blow.

The Sky's the Limit

Hydrogen represents hope — the hope of flying without guilt, of exploring the world without harming it. Projects like Airbus ZEROe show that a zero-emission future is not a dream but a destination within reach.

As technology advances and costs fall, hydrogen could soon fuel not only our planes but also our homes, vehicles, and cities. The journey toward clean energy has already taken off — and this time, it's powered by nothing but science, innovation, and water.

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